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ABSTRACT

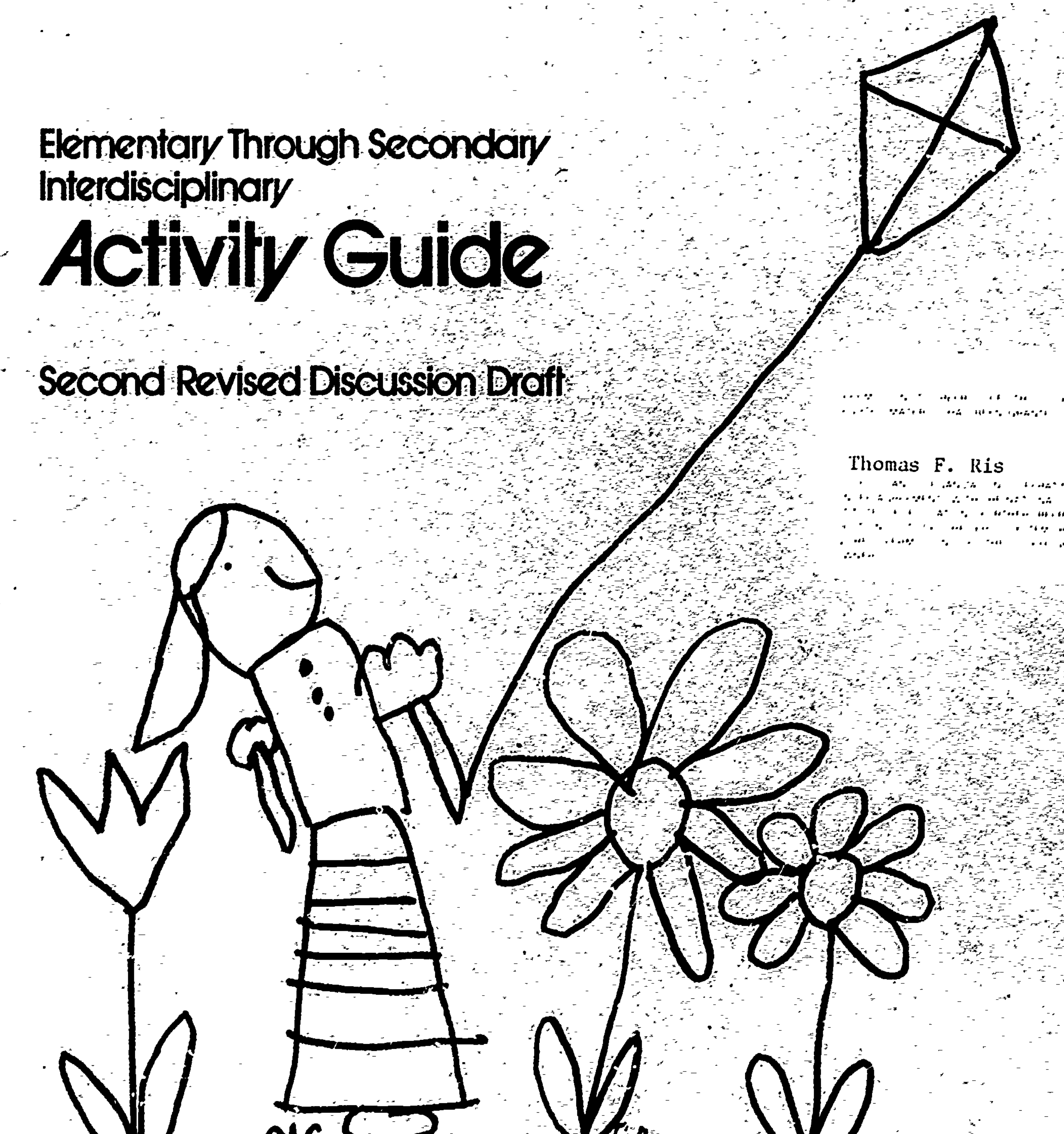
Energy and its relationship to the environment is the topic of this activity guide. The student activities vary in sophistication and can be used at the different grade levels, K-12. These activities are designed for correlation in the existing school curriculum and have as their objectives the teaching of skills through manipulation of materials and independent study, the shaping of positive environmental attitudes, and the developing of an environmental awareness. Each chapter in the guide concerns a new energy-environment concept and is divided into a number of objectives based on four themes--scientific, ethical, aesthetic, and utilitarian. Each of these is further stated as they apply to the various grade levels. And finally, a listing of the activities is given. (MA)

Energy & Man's Environment

Elementary Through Secondary Interdisciplinary

Activity Guide

Second Revised Discussion Draft



Energy & Man's Environment

Elementary Through Secondary

Interdisciplinary

ACTIVITY GUIDE

Second Revised Discussion Draft

Edited by

Thomas F. Ris
University of Washington

Sponsored by a Grant from
The Northwest Electric Utilities to

The Superintendent of Public Instruction
Washington State
Office of Environmental Programs

in cooperation with

The Oregon State Department of Education
The Idaho Department of Education

ENERGY & MAN'S ENVIRONMENT
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ENERGY & MAN'S ENVIRONMENT

Contents

INTRODUCTION

As educators work to foster a greater understanding of society's environmental problems, we can best succeed by teaching the ecological relationships and principles that underlie problems such as Energy. We need to help students learn of Energy's relationship to man's environment, and learn to make decisions about possible alternative approaches and solutions to Energy problems.

"Energy," a term which once had a fairly precise meaning only to a group of scientists, has become more a part of every citizen's vocabulary.

The energy concerns of our society demand that the generation of students now in our schools become environmentally literate to the degree that they understand the environmental implications of human activities viewed from the perspective of social needs and values as they relate to general public policy.

I hope that educators and students will understand the importance of this effort. This is an attempt to help us understand that we must be concerned about our energy resources, and that we, as individuals, can influence the use of a basic resource.

Dr. Frank B. Brouillet
State Superintendent of
Public Instruction

ENERGY & MAN'S ENVIRONMENT

Foreword

The ENERGY & MAN'S ENVIRONMENT Program is a unique educational venture originally developed by the Washington Superintendent of Public Instruction and the Public Power Council. The goal of the EME Program was to provide heretofore unavailable educational materials for teachers concerning the concept of energy and its relationship to man and his environment.

One of the results of this pioneering union between the educational and business community has been the development of this ENERGY & MAN'S ENVIRONMENT Activity Guide. Other EME Program activities include in-service teacher seminars held in many western states, plus the creation of in-service videotape programs for school use, plus special curriculum projects. As this project has grown, thanks to favorable support from area educators, Northwest Electric Light & Power Association has joined forces with the EME Program to expand and accelerate program activities.

The initial wor' on this ENERGY & MAN'S ENVIRONMENT Activity Guide is the result of eleven specialists representing the fields of education, science, resource and analysis, economics and educational media. They include:

Ms. La Von Bucher, Elementary School Teacher, Lake Washington District

Mr. Dick Downie, Director of Nuclear Information and Environmental Coordinator, Snohomish County P. U. D.

Mr. Dan Horn, EME Activity Guide Project Director. Geological and Environmental Sciences, North Seattle Community College

Mr. David Kennedy, Supervisor, Washington State Office of Environmental Programs

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Ms. Loretta Smithburg, High School Science Teacher, Seattle Public Schools

Dr. Dave Stronck, Assistant Professor, General Biology and Education, Washington State University

Mr. Lyle Wilhelmi, Coordinator of Environmental Education, Eugene, Oregon Public Schools

A special note of recognition should be made for Dan Horn, who guided the initial efforts of this Activity Guide in a dynamic manner. His leadership and depth of technical knowledge enabled the EME Program to be both productive and effective.

However, there is still much to be done. It is hoped that each of you will join the EME team by corresponding with us when you have suggestions of how EME material can be improved. A special postpaid evaluation report is found in the Appendix of this Activity Guide for your convenience. Please feel free to write to the EME Program whenever we can assist you to do a better job of helping students develop a truly constructive environmental ethic.

The ENERGY & MAN'S ENVIRONMENT Program is pleased to have the cooperation of many educators in the Northwest. Bus Nance of the Oregon Board of Education and Harry Mills of the Idaho Department of Education have both been very supportive of all EME activities.

Special thanks is due to the many in industry, government and education who have been so generous with their time to help shape the entire EME Program. All of this interest in students' knowledge about energy and its relationship to man's environment is appreciated.

David Kennedy
Supervisor, Washington State
Office of Environmental Programs

ENERGY & MAN'S ENVIRONMENT

Wh· ˜tudy Energy?

Aside from being able to grasp the meaning of the term "energy crisis," which is heard almost daily, the rationale for developing this interdisciplinary Activity Guide is to provide teachers and students, at all grade levels, with an understanding of the role and importance played by energy, in our daily lives. Because most forms of energy are not visible, it is easy to take them for granted. Further there is also the false assumption that the unseen forces of energy will be available forever.

Limited Energy Resources

The world's supply of natural resources, especially those which go into the creation of energy, is finite. The geological forces which create these natural resources operate so slowly that they can be considered non-renewable. Energy producing resources are being used at ever increasing rates by the affluent nations of the world. Until recently little thought or attention has been given to what will happen when these much needed raw materials become scarce and ultimately depleted.

Increased Energy Use

This rapidly expanding use of the earth's natural wealth is particularly significant in North America where one-sixth of the world population resides. This fraction of the earth's population consumes one-half of the earth's annual output of natural resources to produce the goods and services represented by our present-day standard of living.

Environmental Problems

The increased production of goods and services resulting in the increased use of natural resources has caused environmental problems. For instance, manufacturing can create air and water pollution. The utilization of energy-powered equipment, such as automobiles results in 60% of the air pollution problems. Further, when disposing of worn out goods and equipment there are litter and solid waste problems which also demand the use of energy resources.

Political Problems

To compound the problems already noted, the less affluent people of the world aspire to the same economic and social levels currently enjoyed by most western countries. However, experts tell us that there are not enough natural resources to support everyone in the world at the same level of affluence. Many so-called underdeveloped countries are the source of materials rapidly being used by the industrial nations. It is not surprising, therefore, that the prices charged by the underdeveloped countries for their natural resources and raw materials are increasing greatly.

Counter Arguments

It has been said that "the world has ample mineral wealth and that we need only new technologies to exploit this wealth." One point that is neglected in this argument is that it requires energy to transform raw materials into products and to create more energy. The traditional sources of energy are becoming scarce because they are created from limited natural resources. High grade raw materials are found in small quantities. Poor grade raw materials, found in larger quatities, require far more energy to obtain and refine into a usable form. Hence, there are increased amounts of energy used for production and more waste created from the use of low grade resources.

New Sources of Energy

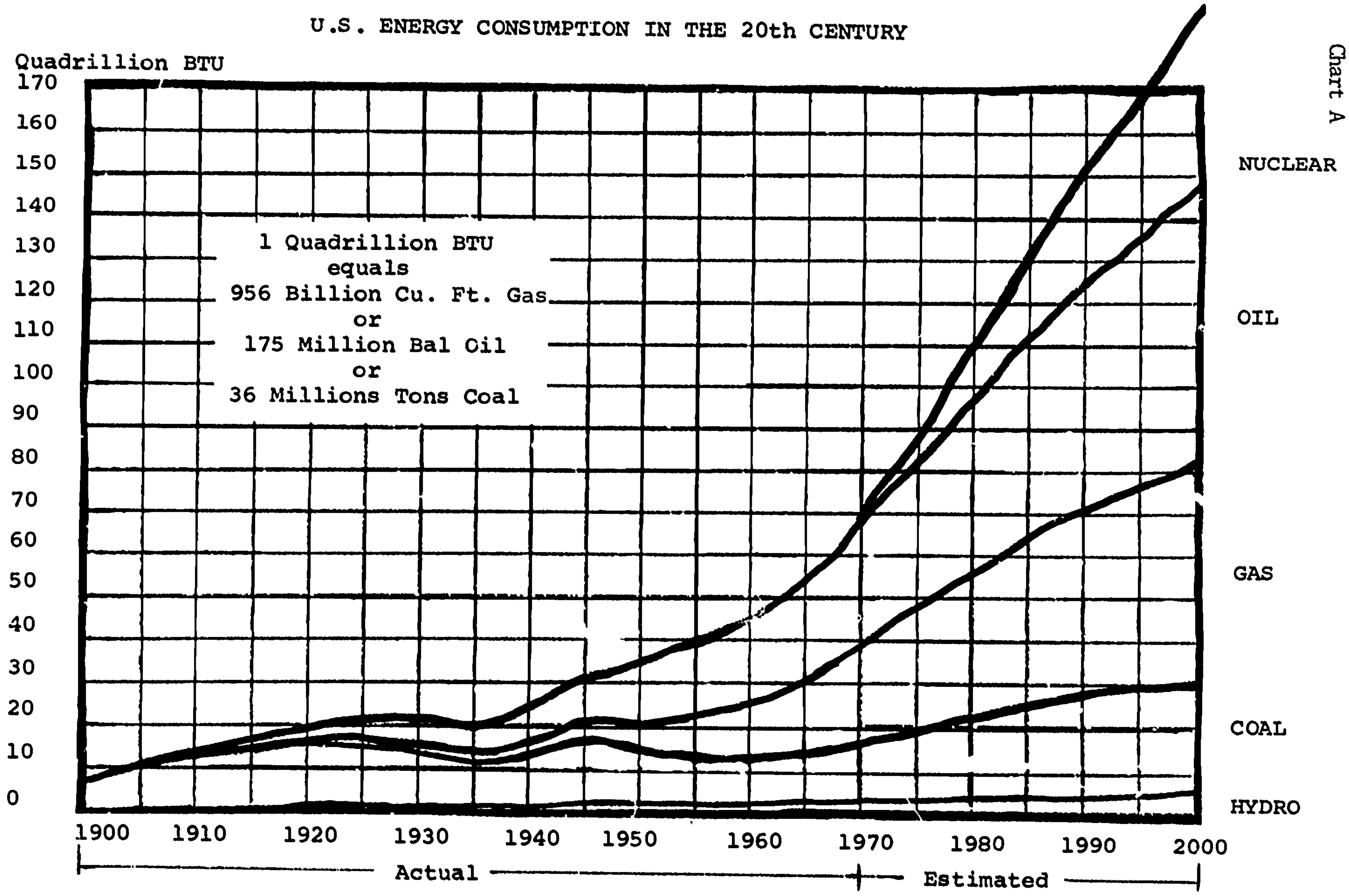
If we are to continue to use large amounts of natural resources, a way must be found to provide more energy to process the raw materials and to eliminate adverse environmental effects. Scientists working on perfecting nuclear breeder reactors think it will be the ultimate answer. The same thought is expressed by those who forecast ways to capture the sun's energy.

Supply and Demand

Presently new energy sources are not keeping abreast with our demands, as noted on Chart A. The United States is now mining coal deposits that were written off as being of too poor a quality to use with any economy.

Chart A

U.S. ENERGY CONSUMPTION IN THE 20th CENTURY



Department of Interior
March, 1971

Further, national attention has been drawn to the side effects of energy conversions, such as air pollution from fossil-fuel (particularly coal) power generating plants, such as those at Page, Arizona and Four Corners, New Mexico, plus the environmental devastation of unregulated strip mining.

The total impact of man on the environment can be stated: such as,...

number of people	x	per capita consumption of goods	x	Environmental impact of production of goods	x	Environmental impact of exploitation of natural resources to make the goods	= TOTAL IMPACT

By examining the above equation, it becomes apparent that man's overall environmental impact can be reduced by diminishing any one or all of the above factors.

Population Growth

The study of population growth in a closed system is a matter of continuing concern. Concepts dealing with unlimited population growth can be useful in influencing the use of the earth's resources.

Clean Manufacturing

Industry is spending a great deal of effort and money to clean up manufacturing processes. However, this is only a part of the solution to the problem.

Increased Consumption

In spite of all of the above examples, little is being done about what scientists and the general public consider to be the most important factor: the staggering increase in the consumption of non-renewable resources to make unnecessary consumer goods, and the increasing tendency toward inefficient, energy-wasting forms of transportation.

An electric can opener, for instance, uses very little electricity but it takes a great deal of energy to produce. Glass bottles and aluminum cans take a great deal of energy to produce, a large part of which is lost forever when they are broken, shredded or "recycled," or when they simply are discarded. Reuse is an answer to consider in packaging. Reusable containers characteristically keep the costs of products down. Chart B shows recent changes in per-capita consumption in the U.S..

Changes in Production or Consumption Per Capita

Item	Period	%Increase
Nonreturnable beer bottles	1946-69	3,778
Synthetic fiber (consumption)	1950-68	1,792
Plastics	1946-68	1,024
Air-freight -- ton-miles	1950-68	593
Nitrogen fertilizers	1946-68	534
Synthetic organic chemicals	1946-68	495
Chlorine gas	1946-68	410
Aluminum	1946-68	317
Detergents	1952-68	300
Electric power	1946-68	276
Pesticides	1950-68	217
Total horsepower	1950-68	178
Wood pulp	1946-68	152
Motor vehicle registration	1946-68	110
Motor fuel (consumption)	1946-68	100
Cement	1946-68	74
Truck freight -- ton-miles	1950-68	74
Total mercury (consumption)	1946-68	70
Cheese (consumption)	1946-68	58
Poultry (consumption)	1946-68	49
Steel	1946-68	39
Total Freight -- ton-miles	1950-68	28
Total fuel energy (consumption)	1946-68	25
Newspaper advertisement (space)	1950-68	22
Newsprint (consumption)	1950-68	19
Meat (consumption)	1946-68	19
New copper	1946-68	15
Newspaper news (space)	1950-68	10
All fibers (consumption)	1950-68	6
Beer (consumption)	1950-68	4
Fish (consumption)	1946-68	0
Hosiery	1946-68	-1
Returnable pop bottles	1946-69	-4
Calorie (consumption)	1946-68	-4
Protein (consumption)	1946-68	-5
Cellulosic synthetic fiber (consumption)	1950-68	-5
Railroad freight -- ton-miles	1950-68	-7
Shoes	1946-68	-15
Egg (consumption)	1946-68	-15
Grain (consumption)	1946-68	-22
Lumber	1946-68	-23
Cotton fiber (consumption)	1950-68	-33
Milk and cream (consumption)	1946-68	-34
Butter (consumption)	1946-68	-47
Railroad horsepower	1950-68	-60
Wool fiber (consumption)	1950-68	-61
Returnable beer bottles	1946-69	-64
Work animal horsepower	1950-66	-84

Another dramatic example of accelerated consumption is the increase in automobile horsepower in the last two decades. The number of cars per capita has increased with a corresponding increase in the consumption of fuel. Vehicle miles traveled per person gives the appearance of increased influence, at the expense of worsened pollution and in the face of diminishing supplies of oil and other resources.

While the use of individual vehicles has increased sharply, the use of mass transportation has declined, thereby replacing less-polluting means of transportation, per passenger mile, with one that pollutes more and uses considerably more energy resources to manufacture and operate.

Environmental Education

> MORE ATTENTION IS PAID TO THE SYMPTOMS OF ENVIRONMENTAL PROBLEMS, SUCH AS LITTER AND SMOG, THAN TO THE CAUSES OF ENVIRONMENTAL DEGRADATION, INCLUDING POPULATION AND PER CAPITA CONSUMPTION.

Environmental education must move in the direction of treating the causes of the problems rather than expending unnecessary and valuable energy on useful but short term remedies, such as litter control and recycling, which merely postpone the inevitable.

Applying the above statement to the problem, the following principles are woven into ENERGY & MAN'S ENVIRONMENT Activity Guide:

1. Energy is the capacity for doing work. It can't be reused and it is required for every natural and mechanical process, from growing plants to building space ships. The cost of something can be reckoned by how much energy it takes to make. Encourage students to see what their personal energy requirements are.

2. Man ultimately must be responsible for his actions. This social ethic needs greater application to the natural world.

3. There are trade-offs. We probably cannot have clear skies if we also demand lots of motor vehicles that run on fossil fuels. If we want full employment, do we need more factories producing more consumer goods and using more raw materials and energy resources (oil, coal, gas, uranium, etc.)? Encourage the students to look at alternatives to their activities.

4. To what degree are affluence and well-being related? A family with a washing machine and a television set is probably more affluent and better off than a family without them, but is the feeling of well-being greater in a family with a washing machine and three TV sets? Encourage your students to examine their level of well-being. What are the costs of luxuries? Who pays those costs? When?

Classroom Involvement

It is assumed that teachers and many students are generally aware of the considerations surrounding the "energy crisis." However, there is a marked absence of materials which provide a balanced and objective picture of energy, energy uses and production, which are designed for classroom use.

As a result, this ENERGY & MAN'S ENVIRONMENT Activity Guide provides the educational strategies and materials needed for introducing this subject at all grade levels on an interdisciplinary basis. It is hoped that this Activity Guide will be the springboard for creative classroom activities as well as some of the solutions to the "energy crisis."

A. D. Horn
North Seattle Community College
September, 1972

ENERGY & MAN'S ENVIRONMENT

Activity Guide Use

Complementary Activities

This Activity Guide is designed for easy adoption for all subjects from K-12. Since it is understood that class curriculums are already completely developed, these learning activities and objectives can be integrated into existing curriculum by merely substituting topics involving energy and its relationship to the environment. The amount of time devoted to these activities depends on your individual teaching plans and schedules.

Chapter Organization

Each chapter is divided into two major sections. The first section of each chapter is directed to learning objectives, by theme and grade. The second section includes learning activities corresponding to the objectives.

Themes

To insure easy adoption for any subject, each chapter has four major themes. These themes can be applied to all curriculum. The themes are:

1. Scientific
2. Ethical
3. Aesthetic
4. Utilitarian

Grade Divisions

Both the learning objectives and activities in this Activity Guide are divided into grade clusters. Teachers are encouraged to select the objectives and activities which best suit their students' needs and levels, since there are variations in any system. These grade divisions include:

1. Primary Grades
2. Intermediate Grades
3. Middle and Junior High
4. Secondary and Senior High

Goals of Activity Guide

Specific goals for this Activity Guide were developed prior to the actual writing of the educational material. These goals are presented here to provide you with the guiding philosophy behind the learning objectives and activities. These goals are:

1. To help the teacher place the student in the role of decision maker;
2. To place the student in the role of learner rather than on the teacher as the disseminator of knowledge;
3. To encourage the student to inquire, explore, invent and solve problems;
4. To develop activities which help the student use his senses and motor skills;
5. To develop activities which help the student evaluate his own accomplishments;
6. To develop activities which place the student in a position to become aware of local conditions, community problems and the outdoors;
7. To encourage the reflection on a system of values that lead to the development of a true environmental consciousness;
8. To develop activities which foster self-reliance and communications skills, as well as aesthetic and ethical considerations;
9. To develop activities which provide follow-up courses of action concerning everyday living needs; and,
10. To develop activities which can be integrated and correlated into existing curriculum in a manner that enhances the instructional goals of the school.

Visual Aids

Many of the charts and graphs found in the text of this Activity Guide are also reproduced on perforated pages in the appendix. These visual aids may be used for reproduction either for distribution to students or for use with overhead projectors or other forms of educational media.

Feedback

On the last page of this Activity Guide is a perforated, postage paid questionnaire for your feedback. Your suggestions, ideas and opinions are openly solicited. Let EME hear from you! Only with your input can future editions of the Activity Guide be improved to help students appreciate their relationship to energy, man and the environment.

ENERGY & MAN'S ENVIRONMENT

Chapter I

USES OF ENERGY

GOAL: Student will explore man's dependence on energy in our society.

SCIENTIFIC OBJECTIVES

PRIMARY GRADES

A. The student will diagram the way in which a windmill works and describe the uses of the windmill.

B. The student will list and describe three types of transportation systems (such as automobile, plane, train, etc.).

INTERMEDIATE GRADES

C. The student will list four uses for each of the following fuels: wood, coal, natural gas, oil.

D. The student will explain the term "energy-mix".

E. The student will list five products made from crude oil and indicate how they are used.

MIDDLE AND JUNIOR HIGH

F. The student will diagram an incandescent light bulb and a vapor lamp, describing how each works. He will then contrast their respective outputs of electric light and heat to those produced by other types of lamps, such as fluorescent tubes.

G. The student will diagram a fluorescent tube and explain how it works, contrasting its electric-light and heat output to that produced by other types of lamps.

H. The student will construct an electrical circuit and explain how it works.

I. The student will describe the process of manufacturing a bicycle, including all energy sources.

J. The student will diagram and discuss at least two methods of space heating, including: oil, gas and electric including forced-air, baseboard and hot water heat transfer methods.

K. The student will construct a simple radio and describe the sources of energy that could be used to operate it.

L. The student will construct a simple generating device and measure the amount of power produced.

M. The student will describe the quantitites of energy used by basic manufacturing industries such as aluminum, iron, copper, etc.

N. The student will diagram and describe the operation of the internal-combustion engine

O. The student will diagram and describe the operation of the diesel engine.

P. The student will diagram and discuss the operation of the steam turbine, such as might be found in steam-electric plants.

SECONDARY AND SENIOR HIGH

Q. The student will state the percentage of electrical energy used in a specific state by the different classes of customer-residential, commercial, and industrial.

R. The student will compare the percentage of electrical energy used in his state against the percentage of electrical energy used in neighboring states.

S. The student will list several of the largest industrial users of electricity.

ETHICAL OBJECTIVES

PRIMARY GRADES

A. The student will state at least three advantages and disadvantages of using each of the following electric appliances:

1. toothbrush
2. toaster
3. hot water heater
4. freezer
5. lights - incandescent and fluorescent
6. space heating
7. air conditioning
8. radio
9. television
10. range
11. dishwasher
12. rotisserie
13. "radar" range (microwave oven)

B. The student will list five different electric appliances used in his home that the family could most easily live without. He will state reasons for each decision and describe what effect this would have on his family.

INTERMEDIATE GRADES

C. The student will contrast the use of rapid transit systems with automobiles.

MIDDLE AND JUNIOR HIGH

D. The student will describe the impact of recreational vehicles on the environment. Include the family automobile when used for recreation.

E. The student will discuss "trade offs" which must be considered before constructing the following:

1. a geothermal generating plant
2. a nuclear generating plant
3. a hydroelectric generating plant
4. a fossil fuel generating plant

F. The student will evaluate the benefits to mankind derived from nuclear power generation. The student will also evaluate the harm which might result from nuclear power generation, including problems of nuclear-waste disposal.

G. The student will discuss the implications of using energy from a non-renewable source to dispose of solid waste containing usable material.

H. The student will compare the lifestyle of an underdeveloped society with his lifestyle. He will consider the energy consumed, and discuss the difference.

SECONDARY AND SENIOR HIGH

I. The student will describe common food and toiletry packages and containers, listing energy sources required to produce them.

J. The student will discuss the political implications of the energy-use imbalance in the world today.

K. The student will discuss the social implications of the energy-use imbalance in the world today.

AESTHETIC OBJECTIVES

PRIMARY GRADES

A. The student will describe five ways in which electric energy has enriched his life.

B. The student will describe five ways in which electric energy has affected surroundings in a negative way.

C. The student will describe five ways in which the automobile harms the environment. He will include, but not limit his list to, such factors as sight, smell and hearing.

INTERMEDIATE GRADES

D. The student will list all forms of freight transportation, beginning with the one which least affects the environment, and continuing in progressive order, to the one with the greatest impact.

MIDDLE AND JUNIOR HIGH

E. The student will describe what he considers the most beautiful site or object in his city, estimating the amount and type of energy used in its creation.

F. The student will describe what he considers the ugliest site or object in his city, estimating the amount and type of energy used in its creation.

SECONDARY AND SENIOR HIGH

G. The student, given the cost of underground wiring versus the cost and maintenance of power poles, will explain how a community might justify the cost of underground wiring.

UTILITARIAN OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

A. The student will compare utility bills from several different households to discover why one family may use more kilowatt-hours than does another.

B. The student will calculate the electric energy that might be saved in one year if his home were to discontinue using each of the following electric appliances:

1. toothbrush
2. toaster
3. hot water heater
4. freezer
5. lights - incandescent and fluorescent
6. resistance electric heating
7. air conditioning
8. radio
9. television
10. range
11. dishwasher
12. rotisserie
13. "radar" range (microwave oven)

C. The student will record at least ten ways in which energy is used in his school.

D. The student will list at least five energy sources on which he depends from the time he awakens until his class begins.

MIDDLE AND JUNIOR HIGH

E. The student will list the number of light bulbs in his home and their wattage. During one evening, he should note the time each light is turned on and when it is turned off, and from this data calculate the kilowatt hours used by these light bulbs.

F. The student will list five reasons why stores and offices today use almost twice the electric energy as they did ten years ago.

G. The student will state which industry uses the most electric energy in his state and why.

H. The student will identify any wood products used as a direct energy source in his home.

I. The student will arrange in order the amount of kilowatt hours per unit utilized by the following industries: pulp and paper, plywood, chlorine and caustic, iron and steel, phosphate fertilizers and aluminum.

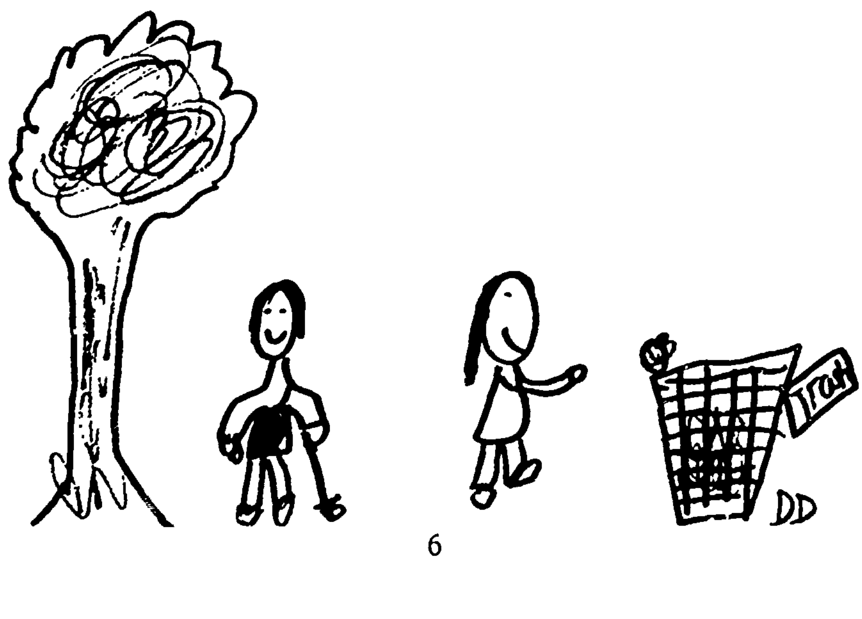
J. The student will contrast the energy units required per passenger mile for each major form of transportation-automobile, bus, plane and train.

K. The student will describe the power source used to generate electricity for his home, school or city.

L. The student will trace the path of electric power from fuel origin to his home fuse box.

SECONDARY AND SENIOR HIGH

M. The student will calculate the proportion of power used in his city by industrial, commercial and residential users. He will then compare the proportionate power use of a large city with that of a small one.



USES OF ENERGY ACTIVITIES

PRIMARY GRADES

SCIENTIFIC OBJECTIVE ACTIVITIES

1. The student will divide a 9" x 12" piece of paper into three sections. In each section, using pictures from magazines or sketches, depict three ways wind is used as a source of energy. (Scientific Objectives C,E)

2. The student will put together a collage using energy terms and illustrations found in newspapers and magazines.

3. Divide class into at least three groups. Each group will draw a mural depicting one transportation system which exists in their area. Arrange for each group to visit its transportation system to gain first-hand knowledge. (Scientific Objective B)

ETHICAL OBJECTIVE ACTIVITIES

4. The student will list the electrical appliances in his home in the order of their importance. List separately the ones he feels could be eliminated without lowering his "quality of existence." (Ethical Objective A)

5. The student will write a letter to the manufacturer of one of the electrical appliances found in his home, asking for information about the source of the materials used in its manufacture. (Ethical Objectives B, I)

6. The student will save all packaging materials from his family's goods for a period of one day. Suggest alternative packaging methods for as many items as possible, considering the following:

   a. biodegradability
   b. efficiency of product use
   c. aesthetics
   (Ethical Objective I)

UTILITARIAN OBJECTIVE ACTIVITIES

7. The student will pretend his school is a modern one with large windows, plenty of overhead lights, and is even air conditioned. Everything seems to be going along very nicely until one day, an area-wide power shortage is announced. Plan for this reduction of the use of electrical energy in the school. What alternatives can be suggested? What reasons support and oppose each alternative? (Utilitarian Objective F)

8. The student will list in order his uses of electricity from necessary to unnecessary. Describe his living conditions without various uses of energy. Develop a scale from a level where he is unable to survive to that of ultimate luxury. Discuss whether happiness is equated with energy--considering luxuries. What would he be willing to give up right now? Contrast enjoyment of a bicycle to compulsory exercise classes. (Utilitarian Objective D)

INTERMEDIATE GRADES

SCIENTIFIC OBJECTIVE ACTIVITIES

9. The student will inventory his home block (teacher provides data sheet for primary grades) to determine the percentage of homes using the various types of energy: coal, oil, natural gas, electricity for:

   A. water heating
   B. space heating
   C. cooking

   Report findings on a bar graph. (Scientific Objective C,D,J,Q)

10. The student will draw a picture showing one home's use of each of the four fuels listed. (Scientific Objectives C, E)

11. The student will make a list of the electric appliances in his home and how much electricity they use (measured in watts). The appliances are labeled. Compare these figures with those which the local electric utility supplies for the "average" toaster, etc., to see if there is much difference between his use and average use. (Scientific Objectives C, D)

12. What is meant by a country's "energy mix?"

13. The student will make a mural which describes the historical progression of fuel uses from wood to nuclear fuel based on man's progressive technological abilities. Include wood, peat, lignite, coal, oil, natural gas, nuclear fission and nuclear fusion. (Scientific Objective D)

14. The student will map the voyage of Ra. Discuss the implications of wind and water power (currents) to world settlement. (Scientific Objective B)

15. The student will construct a simple generating device and measure voltage output. (Scientific Objectives H, L)

    Materials: Large "C" shaped magnet; large iron nail, electrical wire, volt meter.

    Procedure: Wrap large nail tightly with electrical wire, leaving both ends of wire hanging free. Attach each end of wire to one of the leads from volt meter. Pass wire-wrapped nail very quickly back and forth between poles of magnet. The amount of voltage potential generated should be registered on the volt meter.

16. The student will read his home watt-hour meter and school watt-hour meter daily for one week (month?). Discuss the comparative energy consumption. Graph the results. (Scientific Objective Q)

17. The student will make a bar graph comparing the residential and industial consumption of oil, natural gas, and electricity. Use data from Bonneville Power Authority Fact Book, 1969 page 24 (below) or consult your library.

Given the Data from BPA 1971 Status Report

Energy Sales (Billions of KWH)	Actual			Projected	
	1950	1960	1970	1980	1990
Domestic	5.5	13.8	27.5	47.5	77.7
Commercial	2.4	5.2	12.1	22.5	38.3
Industrial	11.1	22.3	44.1	74.7	118.0

(a) Graph the data.
(b) Estimate from the graph the percentage of use by Domestic, Commercial and Industrial in 1970.
(c) Consider how adverse weather conditions affect energy consumption.
(Scientific Objectives M,Q,R)

18. The student will work in small groups to "manufacture" articles or art objects, and record all types and uses of energy involved in the process.

Suggested items for manufacture:

1. Candles-wax, molds, wicks, coloring agents, and candle holders.
2. Clay beads-formation of clay, firing, stringing, and pigment preparation, and finishing.

Class can think of various alternative projects. If articles were to be used as items at a bazaar, more processes would be involved; this activity might be included in an economics unit where real profits and losses could be experienced. (Scientific Objectives B,I)

ETHICAL OBJECTIVE ACTIVITIES

19. The student will find out what regulations exist in his state concerning the use of snowmobiles, trail bikes and/or sand dune vehicles. Discuss in class whether or not the use of these vehicles can be justified on the basis of their energy use and environmental impact. Write an essay

exploring and supporting a position for or against using one of these vehicles. (Ethical Objective D)

20. The student will visit his local drugstore and list ten examples of items he considers "over-packaged." Is transportation or protection of the item, sanitation or ease of use a factor?

21. The student will list ten examples he considers to be "properly packaged." (Ethical Objective I)

22. The student will list all the "energy users" that he personally owns or uses, such as radios, toys, appliances, etc. In the list, state the type of energy required, for such as AC power battery, wind-up spring, etc. After completing the list, compare it with the items a student might own in a nation which uses less energy such as India. Try to list the "energy users" the Indian child might use. (Ethical Objective H)

23. The student will explain why the status quo cannot be maintained in the consumption of power around the world. What share of energy requirements should Americans use, 35%? (Ethical Objective K)

24. The student will make a list of the materials needed to manufacture each of the appliances listed earlier. Indicate amount of electric power needed to operate each appliance. (Ethical Objective A)

25. The student will visit his local dump or transfer station. Explain its operation. Discuss possible alternative means of disposal using the energy from solid waste. (Ethical Objective H)

26. The student will collect packaging entering his household for one shopping day. Bring it to school. Discuss the energy needed to create the total class packaging pile. Suggest alternative packaging. (Ethical Objective I)

27. The student will, on a world map, locate important energy fuels and major energy users. (Ethical Objective J)

28. The student will show how major energy fuels are transported to users and how much energy is used in doing so.

    (a) Find pictures to show transportation.
    (b) Draw diagrams to show energy used by each form of transportation.
    (Ethical Objective J)

29. If he lives near a rapid-transit system (such as the Monorail in Seattle) the student will go for a ride on it. Divide class into groups with parents providing transportation to transit system.

    Record time required to get to rapid-transit system, number of miles traveled, and number of vehicles required to transport class. Also estimate the amount of gasoline used per passenger, and its cost.

When on rapid-transit system, record time required for trip, number of miles traveled, number of passengers per vehicle and cost per passenger.

After returning to school, figure the total amount of time and miles traveled to reach the rapid-transit system. Also figure out the time and miles it would require to travel the same distance using rapid-transit.

Now compare the implications of rapid-transit versus individual transportation. (Ethical Objective C)

AESTHETIC OBJECTIVE ACTIVITIES

30. Divide class into groups. At a different time each day, each group will inventory traffic at a location near the school, recording its findings on a classroom chart.

Date	Time	No. of Vehicles	Vehicles emitting black exhaust	Noisy Vehicles

After all groups have reported, class can tally the last three columns and figure the percentage of vehicles which are polluting air or noise level.

(Aesthetic Objective C)

UTILITARIAN OBJECTIVE ACTIVITIES

31. The student will take a field trip or write a letter to an industrial plant in his area. Find the plant's use/day of electricity and other forms of energy which it uses. Describe the plant process. Discuss the output product, its use, and its importance to society. (Utilitarian Objective G)

32. The student will write a letter to the electrical utility serving his home asking about its policy and costs to change from overhead to underground wiring. Compare costs to those necessary when installing underground wiring at the time of initial building.

SCIENTIFIC OBJECTIVE ACTIVITIES

33. Plastic models exist for demonstrating the internal combustion and rotary engines. Compare these engines for efficiency in horsepower, parts, etc. Compare to the jet engine turbine to show mechanical parts, efficiency, horsepower.

    One-cylinder internal combustion engines are made for model airplanes. Operate one in class to show principles and to collect polluting gas. Test gas from combustion by air pollution experiments for junior and senior high schools.

    Compare gas motor to batteries and A.C. from plg. by attaching each to an electric motor. The motor will do work which is measured, e.g. lifting weights. Windmill may be attached to same. (Scientific Objectives E,N)

34. Based on current statistics, the student will contrast the energy mix of a highly developed country such as the United States with the energy mix of an underdeveloped country. Investigate the amount of energy available in that underdeveloped country as compared to the U.S. (Scientific Objectives C,D,E)

35. Using Figure 1 as the source of data and means for comparison, answer each of the following questions: (Scientific Objectives C,D,E)

True or False

______1. During the period between 1870 and 1970 there was in increase in the amount of energy used in the United States.

______2. During the period 1870 and 1970 the amount of wood fuel used in the United States decreased.

______3. It could be generalized that the amount of coal used for energy between 1870 and 1970 decreased.

______4. During the period between 1910 and 1930 there was a lesser increase in energy consumption than between 1930 and 1970.

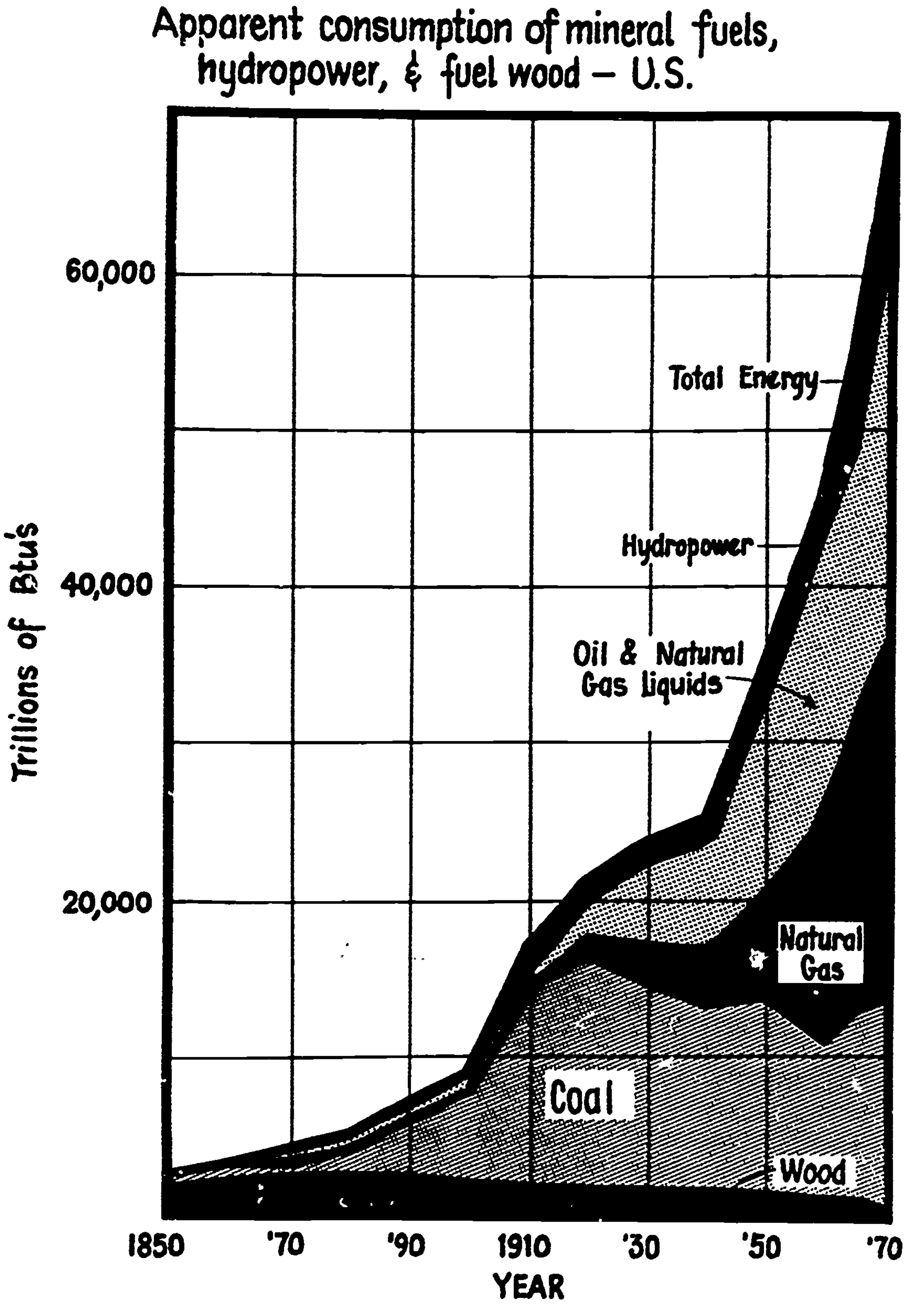
______5. During 1970, the amount of energy used about equals the total amount used in both 1930 and 1950.

Complete the Following Statements:

6. The primary source of fuel in 1910 was ____________________.

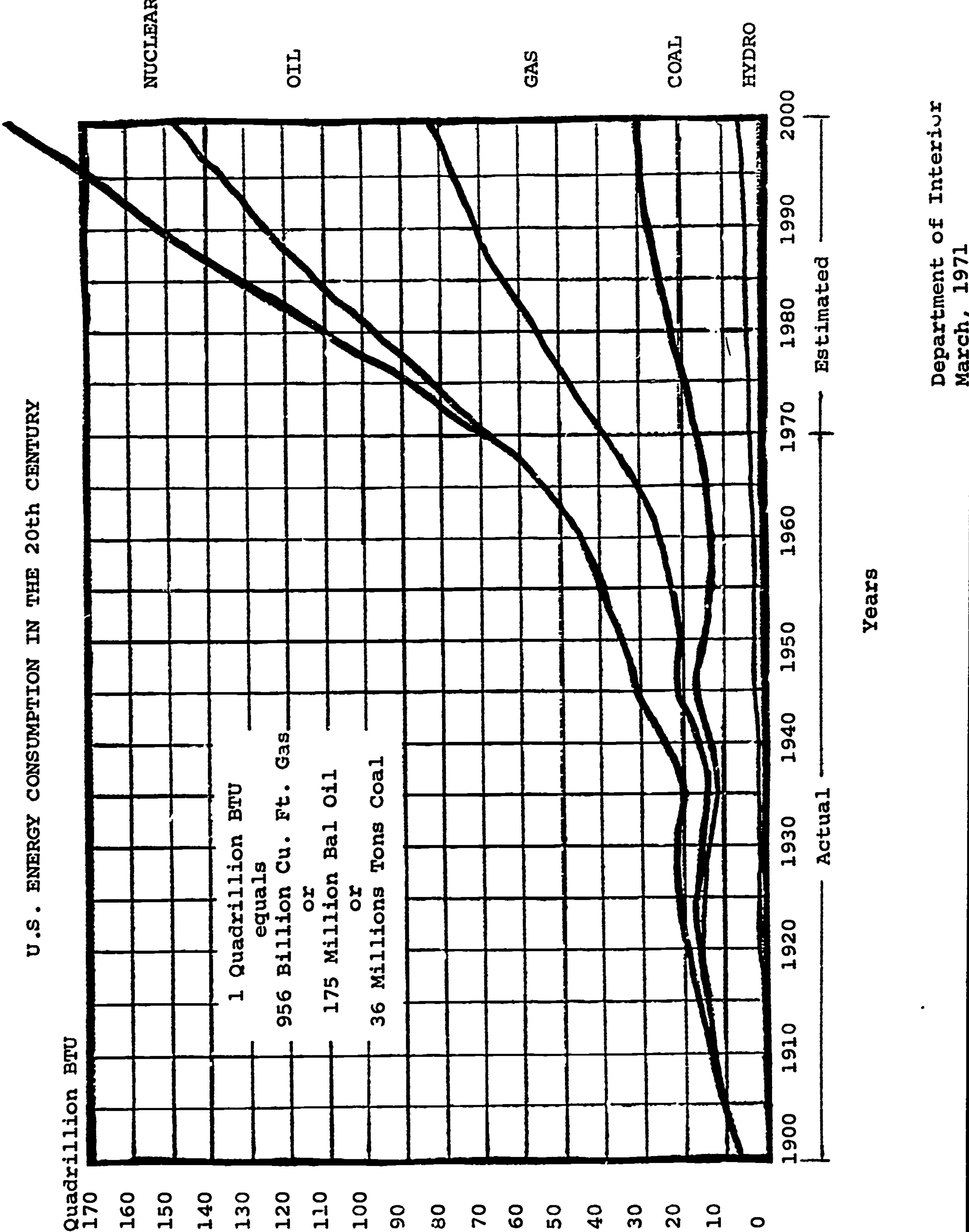
7. In the year of _____ wood fuel was the primary source of energy.

FIGURE No. 1



The Electric Energy Picture in the Pacific Northwest.
U.S. Department of Interior, Bonneville Power Administration, April 1, 1973.

FIGURE No. 2


U.S. ENERGY CONSUMPTION IN THE 20th CENTURY
Quadrillion BTU
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
NUCLEAR
OIL
GAS
COAL
HYDRO
1 Quadrillion BTU
equals
956 Billion Cu. Ft. Gas
or
175 Million Bal Oil
or
36 Millions Tons Coal
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Actual
Estimated
Years
Department of Interior
March, 1971

ETHICAL OBJECTIVE ACTIVITIES

36. The student will list in descending order the amount of radiation naturally occurring in his area; the amount resulting from dental x-rays; the amount resulting from arm or leg bone x-rays; the amount given off by the nearest nuclear power plant per day; the amount used in radiation treatment of cancer. Also consider cosmic Ray Fleet, radioactivity in rock, luminous watch dials. Discuss results.

    Note: Local health department; local dentists, local hospital will be sources. (Ethical Objective F)

37. The student will calculate the energy required to move his body weight one mile by walking; contrast with energy required to move one mile by bicycle; one mile by automobile. (Include the energy required to manufacture the vehicle). (Ethical Objective I)

AESTHETIC OBJECTIVE ACTIVITIES

38. The student will describe the advantages of vacationing in the wilderness. Does the use of trail bikes, snowmobiles, motorcycles, campers, etc. improve or impair such activity and why?

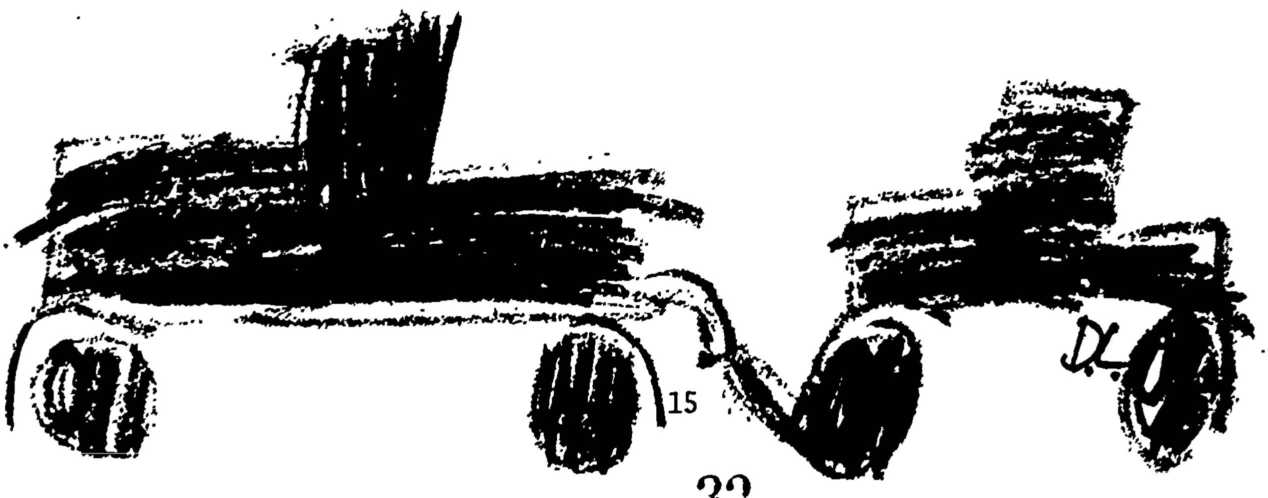
UTILITARIAN OBJECTIVE ACTIVITIES

39. The student will make a list of all means of transporting freight into and out of his community and the energy source required by each. Tabulate the amount of freight each one transports each month.

SECONDARY AND SENIOR HIGH

AESTHETIC OBJECTIVE ACTIVITIES

40. The student will assume that it costs about 20 percent more to build a dam with locks which would allow for shipping purposes. Assume also that an ideal dam site has been developed, but, the citizens (ratepayers) are opposed to the increased costs. How could he defend or oppose the building of locks in the dam. (Aesthetic Objective D)



ENERGY & MAN'S ENVIRONMENT

Chapter II

SOURCES OF ENERGY

GOAL: The student will describe the sources of energy available to man.

SCIENTIFIC OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

A. The student will describe the history, uses and efficiency of early types of energy:

1. man
2. beasts of burden
   a. transportation
   b. treadmill to power-simple machines
3. windmill
4. waterwheel
5. wood

B. The student will construct a chart showing the evolution of fossil fuels (coal, oil and gas) from original plant life to discovery by man.

C. The student will demonstrate the storage of solar energy in plant material.

D. The student will describe the current uses of solar energy:

1. photosynthesis
2. solar cells
3. solar furnace
4. solar water heating

E. The student will describe the process of handling or routing coal, gas oil and electricity from the field or generator to his home.

F. The student will construct a map of the world which shows the location of major energy sources (coal, oil, natural gas, wood, uranium, hydroelectric, geothermal).

G. The student will describe the limitations and advantages of obtaining hydrogen by electrolysis and then using it as a basic power source.

MIDDLE AND JUNIOR HIGH

H. The student will describe how uranium, thorium, plutonium and other radioactive elements are used as fuel for nuclear reactors:

1. boiling-water reactor
2. pressurized-water reactor
3. high-temperature gas-cooled reactor
4. Breeder reactor
   (a) Liquid Metal Fast Breeder Reactor (LMFBR)
   (b) other

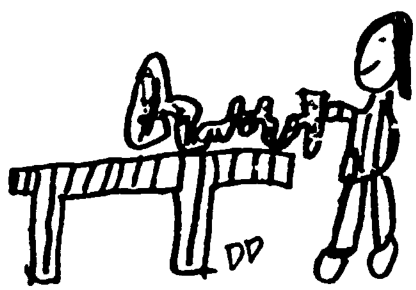
I. The student will describe the use of radioactive isotopes in medicine and industry.

J. The student will describe the limitations and advantages of geothermal sources of energy.

K. The student will describe the limitations and advantages of tidal flows as a source of energy.

SECONDARY AND SENIOR HIGH

None



ETHICAL OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

A. The student will list the positive and negative considerations surrounding the industrial, commercial and residential use of energy (coal, oil, gas, wood, nuclear) in terms of:

1. pollution
   (a) air
   (b) water
   (c) radiation
   (d) visual (plant, fuel storage, etc.)
2. location
3. impact on people
4. economic impact
5. mining
6. processing
7. transportation

B. The student will describe desirable limitations of individual energy use. How does individual use of energy affect others? If he stopped using energy, how would that affect others?

C. The student will evaluate the implications of substituting "less-polluting" fuels for "more-polluting" fuels considering efficiency, economics and environmental impact.

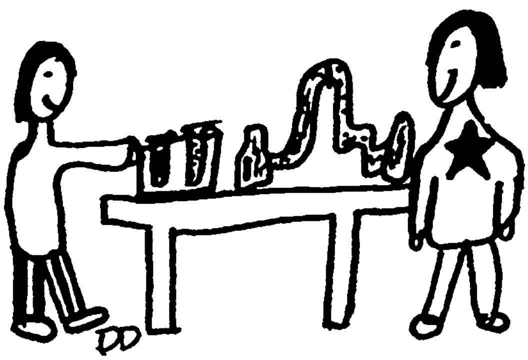
D. The student will list the priority for energy uses in the event of a shortage. Describe how to determine, implement and enforce such a procedure.

MIDDLE AND JUNIOR HIGH

None

SECONDARY AND SENIOR HIGH

None



AESTHETIC OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

A. The student will describe ways to minimize bad effects of obtaining resources:

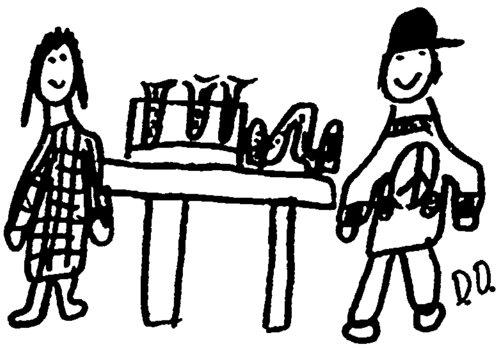
1. coal (mines, strip mining)
2. oil (derricks, pipelines, offshore)
3. gas (pipelines, pumping stations)
4. wood (clear-cutting, transporting)
5. electricity (considered as a fuel)
6. nuclear fuels (mining)

B. The student will describe the aesthetic effects of mining, refining and delivering:

1. coal
2. oil
3. gas
4. wood
5. hydroelectric energy
6. nuclear-generated electric energy

MIDDLE AND JUNIOR HIGH

None



SECONDARY AND SENIOR HIGH

None

UTILITARIAN OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

A. Disregarding variables of supply, the student will give the advantages and disadvantages of coal, oil, gas, wood, nuclear energy and solar energy as sources of energy.

B. The student will list the transportation requirements of coal, oil, natural gas and electricity.

C. The student will compare the sources of energy available to people living in the continental U.S., and compare the uses of energy by people living in:

1. Hawaii
2. Australia
3. Japan
4. Egypt
5. India
6. Alaska

D. The student will define fuels, answering these questions:

1. What are they?
2. Where are they?
3. How do we get them?
4. How do we refine them?
5. What are they used for?

MIDDLE AND JUNIOR HIGH

E. The student will compare the employment requirements necessary to deliver comparable energy to a customer using:

1. coal
2. gas
3. oil
4. wood
5. hydroelectric
6. nuclear electric
7. coal/electric
8. gas/electric
9. oil/electric
10. nuclear/hydrogen

F. The student will compare the economics of supplying the energy to the consumer using the energies listed above.

SECONDARY AND SENIOR HIGH

None

SOURCES OF ENERGY ACTIVITIES

PRIMARY GRADES

SCIENTIFIC OBJECTIVE ACTIVITIES

1. The student will make a collage depicting past and present uses of energy. (Scientific Objective A)

2. The student will draw a map of a specific continent and fill in on that map the location of energy sources.

3. The student will demonstrate the heating effect of sunlight by putting a pan or bottle of water in the sun and comparing the temperature with a similar quantity and container placed in the shade.

INTERMEDIATE GRADES

4. The student will construct a chart showing the transition from plants to coal.

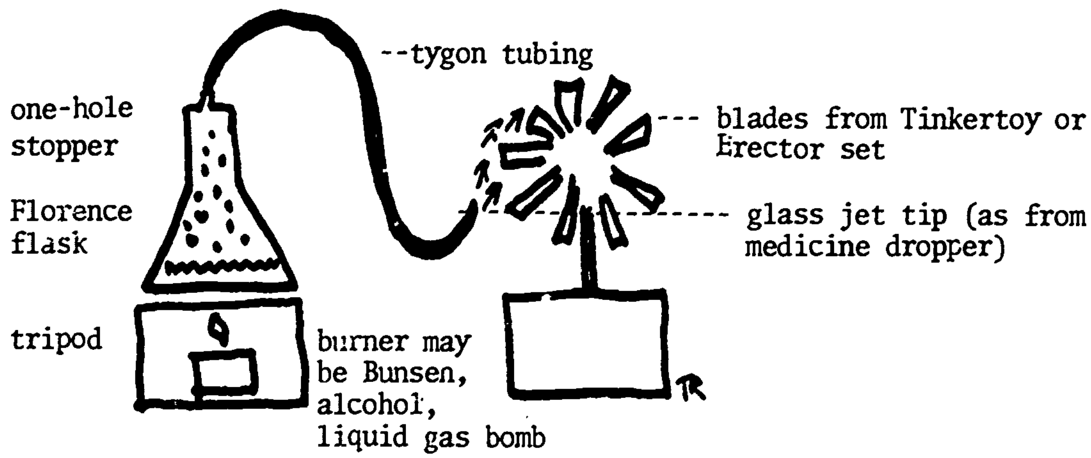
   plant material→ peat→ lignite→ bituminous coal→ anthracite coal
   time, heat & pressure
   increasing cost more heat,
   less abundant

   Describe how man uses each of these. (Scientific Objective B)

5. The student will remove the handle from an old umbrella. Line the inside of the canopy with aluminum foil. Point it at the sun and concentrate the focused energy on a beaker of water. (Scientific Objective D)

6. The student will demonstrate the effect of concentrating solar energy with a magnifying glass by igniting paper. (Scientific Objective D)

7. The student will make a model of a steam engine by using a jet of steam from a boiling flask to power a wheel. (Scientific Objective H-1)



The turning wheel can be made to do work, such as lifting weights.

8. The student will contact the executive director of a local hospital. Ask for a tour of the hospital to observe the uses of radioactive isotopes in medicine, such as:

   (a) the cure of disease
   (b) the detection and prevention of disease
   (c) many other laboratory uses

   Discuss with the hospital staff the advantages and disadvantages of using radioactive isotopes. (Scientific Objective I)

ETHICAL OBJECTIVE ACTIVITIES

9. The student will tie white muslin collecting bags on the exhaust pipe of a small automobile, a large automobile, a bus, a diesel truck and a motorcycle for one minute each. Compare the findings.

   Set squares of white paper inside and outside a house, inside and outside a school, near a manufacturing plant, and in the downtown area. Each for a 24-hour period. Compare the findings. (Ethical Objective A)

10. Have a debate on this topic:
    Resolved: An individual's use of energy can be limited without undue loss of personal freedom. (Ethical Objectives A,B)

11. The student will describe changes in his family's activity for an average day if they had no automobile. (Ethical Objective B)

MIDDLE SCHOOL AND JUNIOR HIGH

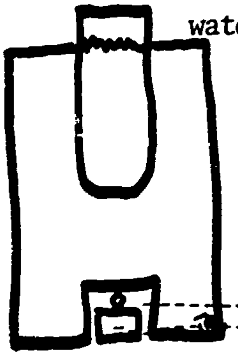
SCIENTIFIC OBJECTIVE ACTIVITIES

12. The student will compare the construction of an early American wagon road with that of a modern freeway. (Scientific Objective A-2)

13. The student will compare the starch in a plant kept in the dark for 48 hours to a plant in sunlight. (Remove chlorophyl in a leaf by immersion in hot alcohol and testing with iodine. A blue-black color shows the starch produced by photosynthesis.) (Scientific Objective C)

14. The student will build a solar furnace made of plaster of paris and aluminum foil in a parabolic shape, with the heat collector at the focal point of the parabola.

Set it up this way



Demonstrate the energy (in calories) in the nut by burning the nut and measuring the temperature rise of the water. (Scientific Objective D)

15. The student will raise bean plants until leafed-out plants have cotelydons above the surface. Remove the cotelydons. Place half of the plants in the dark for 2 weeks or more. Then remove all the plants from the soil and dry them until their weight is constant (this probably will require another week.) Weigh the plants. Record results and make observations about findings.

    The weight of this plant material can be converted to calories by burning the dry plant material on a wire screen below a water can. A calorie is calculated by a change in the temperature of the water times the weight of the water in grams, etc.

    Use mirrors to reflect sunlight against the surface of a can. Measure the calories. Compare that with heat from the plant. Calculate the efficiency of the plant surface to utilize light versus that of the surface of a mirror. (Scientific Objective D)

16. The student will measure the electrical output of a solar cell when it is exposed to direct sunlight and when it is covered. Cadmium sulfide cells are not appropriate because they merely change their resistance in different light levels. (Scientific Objective D)

17. Using a map of the world, the student will identify all the locations where geothermal activity might be used as a potential source of energy. Evaluate whether it would be practical to use each of those sources to produce energy.

    What aesthetic qualities should be considered for the use of a geothermal source for energy? (Scientific Objective H-1)

18. With a Geiger counter, the student will determine the relative amount of energy by plotting the number of counts from a standard distance for:

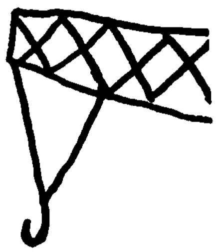
(A tritium-based coating will not give a reading)

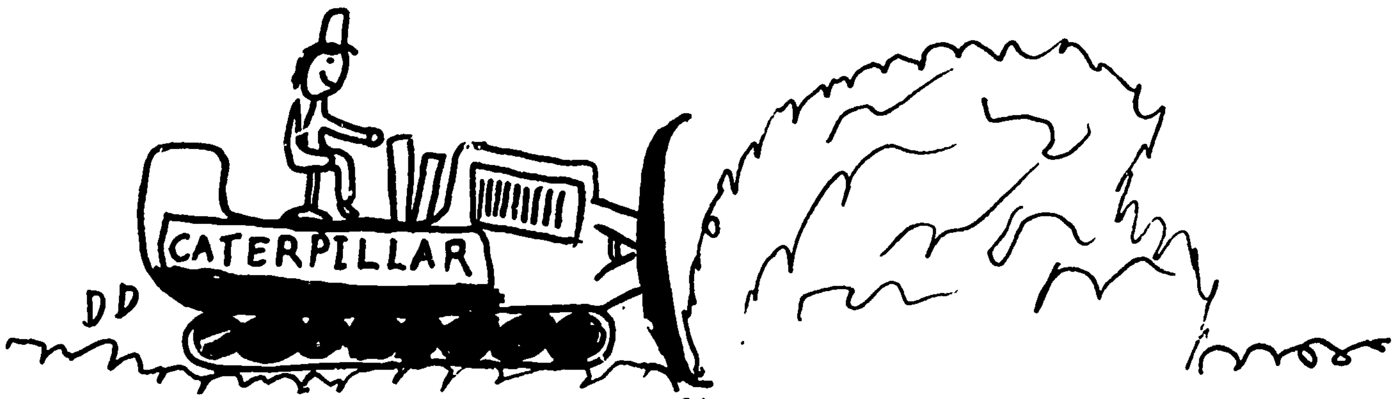
(a) a watch with a radioactive dial.
(b) a watch with a radioactive dial but with the crystal removed.
(c) a piece of granite
(d) a piece of coal
(e) a bottle of iodine
(f) a Coleman-lantern mantle

(Scientific Objective H-1)

19. It has been suggested that tidal energy is a large untapped source of energy. The student will consider himself a member of a commission to evaluate a proposal to use tidal energy. List the problems the commission would study. What would be the recommendations? (Scientific Objective H-1)

20. The student will visit a local nuclear power plant. Find out the type of reactor it is, what fuel is used, what type of condenser cooling is employed (cooling tower, river, ocean, etc.), what is the transportation and disposition of spent fuel and radioactive waste. Discuss different types of reactors and cooling methods. (Scientific Objective H)





ENERGY & MAN'S ENVIRONMENT

Chapter III

CONVERSION OF ENERGY

GOAL: The student will understand the processes of conversion from one energy form to another.

SCIENTIFIC OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

A. The student will list sources of energy used by men in historical sequence. Include nuclear, falling water, wind, natural gas, wood, geothermal, coal, tidal, oil, chemical, solar, electrolysis by nuclear power, and other hydrogen-producing means.

B. The student will list and evaluate the positive and negative counter balance of various energy source uses (i.e. fossil fuel versus nuclear fuel, electric plants).

C. The student will list examples of energy sources that are used without conversion.

D. The student will list the wastes resulting from energy conversion.

E. The student will list two major energy sources that come from solar radiation.

F. The student will list examples of energy conversion.

G. The student will describe various methods of transporting energy producing material from source to point of use, and the effects of that on the environment.

MIDDLE AND JUNIOR HIGH

H. The student will describe the waste products of the internal combustion engine.

I. The student will describe the conditions necessary for reduction of pollution caused by the internal-combustion engine.

J. The student will describe the waste products from oil-fired, gas-fired, or nuclear-fired electric generating plants.

K. The student will list the methods of transporting energy-producing materials in order from least harmful to most harmful to the environment, and defend that order.

L. The student will describe the waste products which come from the conversion of coal to "heat energy."

M. The student will describe the conversion and transport process from source to consumer when electricity is the product. Include the loss of electric power during transmission and propose alternatives for using the original energy source more efficiently.

N. The student will compare fission and fusion reactors for the production of electrical power.

O. The student will describe the solar cell, its benefits and its limitations.

P. The student will describe the compressed hydrogen fuel cell, its benefits and its limitations.

Q. The.student will select the one major source of electric power he thinks will be most used in the future, and substantiate that choice.

R. The student will list ways in which energy consumption can be reduced without decreasing the quality of life.

SECONDARY AND SENIOR HIGH

None

ETHICAL OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

A. The student will construct a set of guidelines for the use of rapidly diminishing sources of energy (i.e., should fossil-energy resources be used to depletion as a fuel source?)

MIDDLE AND JUNIOR HIGH

B. The student will construct a model that constitutes "the good life" which can be used as background for making judgments concerning energy-resource use, considering both himself and others.

C. The student will describe the implications of an attempt to control pollution from internal-combustion engines.

D. The student will enumerate the ethical implications of one social group using 25 times as much of an unrenewable resource than another social group.

E. The student will list the ethical and practical considerations to be made when disposing of energy conversion wastes.

SECONDARY AND SENIOR HIGH

None

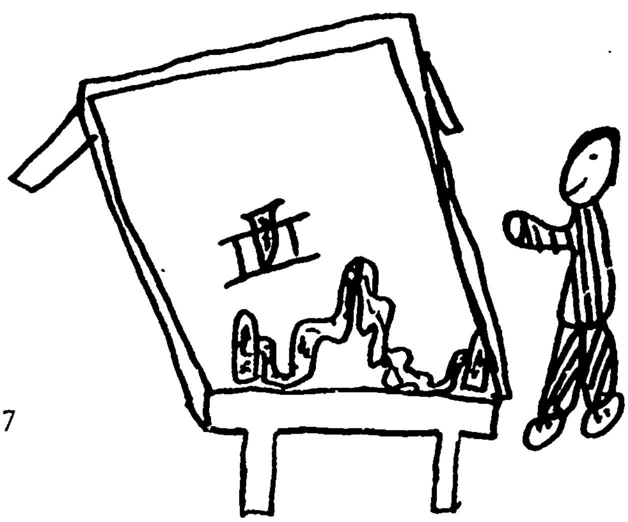
AESTHETIC OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

None



MIDDLE AND JUNIOR HIGH

A. The student will construct a priority list of energy conversions in order from aesthetically less pleasing to aesthetically more pleasing.

B. The student will construct a list of energy-producing substances and order the method of transport of those substances from aesthetically less pleasing to aesthetically more pleasing.

C. The student will list the energy conversion and transfer processes and contrast the aesthetic and utilitarian advantages of each.

D. The student will list aesthetically acceptable means of disposing of energy conversion wastes.

E. The student will state what kind of fuel-fired electric plant he would prefer as a neighbor, and defend his choice.

F. The student will list the by-products of energy conversion which he finds aesthetically objectionable.

SECONDARY AND SENIOR HIGH

None

UTILITARIAN OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

A. The student will construct a list of energy conversions in order of their utility for society, and defend that order.

MIDDLE AND JUNIOR HIGH

B. The student will construct a list of methods of transporting energy-producing substances, presenting them in order of their utility for society, and will defend that order.

C. The student will list some alternatives to internal-combustion energy.

D. The student will list some possible damage from internal-combustion engines.

E. The student will describe the political or private group which he thinks should control energy production.

F. The student will list some vocational implications of a shift in dependence upon one energy source to another.

SECONDARY AND SENIOR HIGH

None

CONVERSION OF ENERGY ACTIVITIES

PRIMARY GRADES

SCIENTIFIC OBJECTIVE ACTIVITIES

1. The student will try to list every nonliving thing he can think of that moves. Opposite each object list what energy causes that movement. Discuss whether or not movement in nonliving objects can occur without energy to power that movement. (Scientific Objective F)

2. The student will place a shiny metal object in a candle flame. What is the deposit that appears on the metal. Where does it come from? Could there be a use for it? (Scientific Objective D)

3. The student will place a beaker or jar over a burning candle. Water will collect on the inside of the jar. Water vapor is a waste product in any combustion process. Could there be a use for this vapor? (Scientific Objective D)

4. The student will place a piece of filter paper in the exhaust stream of an automobile for several minutes, then inspect the filter for deposits. Caution: CO is dangerous. (Scientific Objective H)

INTERMEDIATE GRADES

SCIENTIFIC OBJECTIVE ACTIVITIES

5. The student will make a "timeline" to record energy sources, in historical sequence. How was each formed? What was the origin of its use and need? How did its use progress?

   Make a "timeline" for each source and show its historical development. Use drawings, pictures and charts to show changes.

   (Teacher's instruction: Make a "timeline" on butcher paper indicating the correct historical sequence.)

   Find magazine pictures that depict sources of energy and mount them in the proper time slots on the time line. Make a mural with your pictures. (Scientific Objective A)

6. The student will pretend he is going to Disneyland. Select his method of transportation, what he'll eat, what he'll do at Disneyland, and all other items.

Plan the trip, with $120 to spend.

How to get to Disneyland?

	Time	Cost
Car	16 hours	$ 9.80
Train	10 hours	$17.25
Plane	3 hours	$31.75

What to do at Disneyland?

All exhibits and rides cost $1.50 each. (List what type of energy is used for each.) A book of 20 tickets costs $22.50.

Food?

How will it be prepared and served? Where to eat? What waste will be involved?

Motel while at Disneyland. $12 per day. (Is there an alternative?)

The student must get to Disneyland and back home in three days. What will his choices be? Will he have to make any "trade-offs?" Will he spend all his money? (Scientific Objective B)

7. The student will pretend that four groups of people are going to set up housekeeping beside a common stream; their land is contiguous. They will generate their own energy. Group 1 will set up a coal-fired generating plant. Group 2 will set up a gas-fired generating plant. Group 3 will set up a nuclear fired generating plant. Group 4 will set up a hydro-powered generating plant. Join one of these groups.

   Each group may oppose the erection of any other group's plant on the basis of pollutants, passage of fuel across their territory, use/abuse of a common resource such as air or water.

   Defend the plant of one group, but eventually you decide the best possible method of generating electricity: whether it should be a common source or several generators and which one. If a common source is selected, whose land will it occupy and what compensation will be provided for the land use? (Scientific Objective B)

8. The student will pretend he is going on a camping trip 200 miles from home. The length of the vacation is two weeks. He wishes to spend as little money as possible, spend as much time in the wilderness as possible and contribute as little pollution as he can. Based on these requirements, select a mode of travel, cooking fuel, housing en-route, housing at the camp site, types of activities during the period at camp. (Scientific Objective C)

9. The student will make a list of energy sources that are used without conversion, such as:

   (a) Floating logs down a stream
   (b) Flying a kite
   (c) Sailboats
   (Scientific Objective C)

10. The student will bubble exhaust gases through lime water to determine if carbon dioxide is present. Caution CO is dangerous. (Scientific Objective H)

11. The student will bubble exhaust gases through water and test with pH paper to determine if acid-forming substances are present in the exhaust. (Scientific Objective H)

12. Have an automotive dealer who has an exhaust-emission analyzer bring it to class and show how it is used. Observe what adjustments are made to the automobile to reduce undesirable emissions. Find out what other accessories not yet fitted to automobiles, might reduce undesirable emissions. (Scientific Objectives H,I)

13. The student will grow a plant in sunlight, dry the plant, weigh it and compare the weight with the weight of the original seed. Discuss solar energy and plant synthesis. (Scientific Objective E)

14. The student will burn wood splints with solar radiation. What type of energy is this? How does it work? How does it compare with other energy sources? (Scientific Objective E)

15. Using a recipe for cooking jam with only solar energy, the student will determine the "cooking" time for a typical summer day in Seattle, Spokane, Portland or Albuquerque. (Scientific Objective E)

16. Using salt water, the student will build an evaporation tank with a flat baking pan. Keep records of how long it takes the water to evaporate and how much salt is produced by this method. (Scientific Objective E)

17. To determine whether an energy conversion process is converting one form of energy to another, the term "efficiency" is used. The student will determine a formula or rule that could be used to find out if a particular process will be "efficient" or not. How would he know whether one process will be more efficient than another? (Scientific Objective F)

18. The student will go on a "field walk" with a small group of other students and list all the energy conversion he sees. Do it in this manner:

Object Viewed	Energy Source	Ultimate Product
Automobile	Gasoline	Motion
Light Bulb	Electricity	Light
Sailboat	Wind	Motion

(Scientific Objective F)

19. The student will research and prepare presentations for each of the roles presented below:

You are a large distributor of oil in a metropolitan area. You are located in an area accessible to the transportation facilities listed below. You wish to transport the oil to your distribution plant with maximum efficiency and the least adverse effects on the environment. Representatives from the following transportation facilities present their "sales pitch" to you and your directors:

(a) railroads
(b) trucks
(c) freighters
(d) pipelines

Which means will you choose and why? (Scientific Objective G)

20. The student will draw lines on a world map showing the major sea lanes between oil-producing countries and those countries dependent on petroleum products. (Scientific Objective G)

21. The student will request permission from a local power utility to visit its switchyard and substations. Have a utility representative explain the function of the switches, capacitators, breakers, transformers and insulators. Find out from him and from the library how much power is lost in transmission and why. (Scientific Objective M)

ETHICAL OBJECTIVE ACTIVITIES

22. To conserve gasoline, a decision has been made to reduce the number of automobiles in this country. The student will draft a set of priorities and regulations to accomplish this as fairly as possible for all citizens. (Ethical Objective A)

23. By interviewing other people, the student will find out what the "good life" is as seen by students and what it is as seen by adults. (Ethical Objective B)

24. The student will find out what people in his community think should be done to control auto pollution. Make findings known to legislators. Invite a city councilman to visit the class so that the issue can be discussed with him. (Ethical Objective C)

25. An ordinance has been passed ordering all users of electric energy to reduce their use by one-half. The student will explain what he would choose to do without and why. (Ethical Objective D)

AESTHETIC OBJECTIVE ACTIVITIES

26. To convert energy, from coal to steam to electric energy, some type of facility or plant must be constructed. From a series of pictures (take them with a camera or clip them from electrical trade journals) the student will prepare a bulletin board which illustrates plants which are more attractive and those which are not. In a discussion, point out features of the more attractive plants. (Aesthetic Objective A)

27. The student will visit "power corridors": transmission-line corridor, gas-pipeline corridor, oil-pipeline corridor, highway corridor.* Discuss the advantages and disadvantages of lumping them together in one corridor. (Aesthetic Objective B)

28. The student will photograph areas of his community with underground wiring and areas of the community with overhead wiring.

    Interview residents in each area to find out what "dollar value" they would place on the aesthetic advantages of underground wiring. Then find out if this "dollar value" is close to the actual cost per household for underground wiring.

    How is the cost of underground wiring met in a new subdivision?

    Ask the power company to state advantages and disadvantages of underground and overhead wiring. See what can be added to that list. (Aesthetic Objective B)

29. The student will pretend his neighborhood is to have a fuel-fired electric plant installed. The kind of plant has not yet been determined but a hearing has been scheduled by the city council and planning commission. Research the problem. Choose one of the roles listed below and act out such a hearing:

    Mayor
    Council members
    Representatives of each type of fuel-fired plant
    Citizens for and against each kind of plant

    (Aesthetic Objective E)

    SEE SIMULATION GAME AND INSTRUCTIONS ATTACHED

*Discover (from each utility if necessary) the needs of each.

DEVELOPING A SIMULATION GAME

Identify the problem or issue to be decided upon.

Identify the choices available to the decision makers.

Identify the factors having an influence on the decision.

Identify indiviual or group roles.

Identify the factors (for or against) assigned to each role.

Establish conditions for the players (i.e., resources, voting procedures, bargaining money, etc.).

Develop specific goals or objectives for the players.

Include limits or rules for what is permissable behavior (time factor, trading, number of points, money allocations, etc.)

30. The student will go to the kitchen of a restaurant or hotel and itemize the utensils or equipment that aid in the conversion of one form of energy to another. Design a utensil that will do the same work but which is not as wasteful as that of the restaurant. (Aesthetic Objective C)

31. List energy-conversion products (heat, gas, water, light, electricity, neutrons, torque noise, work, etc.) The student will choose one and assume and play a role in which he assumes the identity of that product.

    Get together with another "product" unlike himself and decide how he would like to be treated as society disposes of him.

    Present conclusions to the class. (Aesthetic Objective F)

32. The student will list different forms of recreation (boating, skiing, football, hiking, motorbiking, etc.) discuss the energy form and amount consumed by each. Try to compare similar forms of recreation that do and do not consume energy (sled vs. snowmobile, hike vs. auto, etc.)

    List different forms of recreation and describe the health value of each, ranging from very healthful to harmful.

    Compare the two lists. What are the implications for the student's life?

UTILITARIAN OBJECTIVE ACTIVITIES

33. The student will participate in a spelling bee that uses words about energy: potential --- kinetic --- heat --- light, etc. (Utilitarian Objective A)

34. The student will discuss the economic and occupational implications of a law that would prohibit the conversion of fossil resources to heat energy.

    List items in the classroom that could not be replaced if this type of energy conversion was banned. (Utilitarian Objective A)

35. The student will attempt to construct a world in which photosynthesis did not exist. Use everything available under these new conditions. Assume that man has found a way to sustain himself.

    From this model the student will recreate his city. List the energy sources we use that have come from photosynthesis. (Utilitarian Objective A)

36. Should each home deliberately diversify sources of energy e.g., use gas, electricity, wood in fireplace, oil, etc.? Will this save on costs of fuels? (Utilitarian Objective A)

37. The student will take a field trip through a housing development where the utility (electric, telephone, cable-television) lines are buried and then to one where the lines are strung overhead on poles.

Discuss the following:

(a) Which method of energy distribution is more appealing and why? Draw a picture of each. Draw a picture of a neighborhood as it would look without the poles that are there now.

(b) Which method would cost more to install initially?

(c) To what extent would the student prefer to pay more for a more appealing environment?

(d) Find out how much it would cost per house to bury utility lines in areas where they are presently on poles.

(Utilitarian Objective B)

38. What should be the policy of homeowners and other citizens about the potential increased costs of natural gas due to shortages? Should homeowners now put electric heating into new homes? How do people become aware of such problems? Should each person make such a decision on his own, or should there be advice or direction provided for him? (Utilitarian Objective B)

39. Should an automobile driver drive less because of the rising cost of gasoline? What should he do? What can he do? If he has the money, should the auto owner be able to buy as much gasoline as he wishes? (Utilitarian Objective C)

40. There are about 100,000,000 motor vehicles in the United States. Most of the vehicles are for personal use. The student will pretend he is to write a law which restricts the use of personal autos to reduce air pollution and space pollution. What will he say in the law?

What kinds of argument would he anticipate from opponents of this law? How do other countries get along without the automobile? (Utilitarian Objective C)

41. Today in Europe there are many ancient statues and buildings that are in danger of being dissolved or permanently disfigured, not by vandals but by something else.

Solve this mystery.

(a) Who or what is causing the destruction?
(b) How can it be stopped?
(c) Should we worry about this problem?
(Utilitarian Objective D)

42. The student will describe uses of nuclear reactors as a source of power. Should reactors be used on railroad locomotives? (Should trains be run on electricity?) (Utilitarian Objective E)

43. The class will divide into groups. The student will join one of these groups:
(a) manufacturers (including textiles, aluminum, automobiles;
(b) conservationsists, Sierra Club;
(c) city, county and state planners;
(d) [illegible] companies, coal-mine owner, foresters;
(e) general public and other interest groups (e.g. parents, teachers, workers).
Each group must assert its right to control the production and use of the energy resources of the world and must defend its position. (Utilitarian Objective E)

44. The student will speculate on the type of job he thinks was most prevalent when wood fuel was a major source of our nation's energy. Then consider this same problem regarding coal, oil, natural gas, electricity.

Suppose we were able to convert the sun's energy directly. What new types of jobs would be available? Which types of jobs do you think would be eliminated or reduced? Give reasons. (Utilitarian Objective F)

MIDDLE AND JUNIOR HIGH

SCIENTIFIC OBJECTIVE ACTIVITIES

45. The student will evaluate the advantages and disadvantages of automobiles powered by internal combustion engines and those with electric propulsion. Formulate a statement as to how future cars should be powered and why. (Scientific Objective B)

46. Assume a perfect fuel would....

_______ be unlimited in supply
_______ be equally distributed throughout the world
_______ present no technological problems
_______ be highly efficient
_______ present no aesthetic problems
_______ have no adverse impact on the environment

The student will select the fuel he feels is the most nearly perfect fuel and defend this choice. If another class member selects a different fuel, discuss the matter with that student. (Scientific Objective B)

GAME

47. This game consists of starting each player with $100,000 of play money. By rolling dice they have turns in the sequence of low to high numbers. There are stacks of cards representing:

 (a) Utilities with different types of energy sources.
 (b) Raw materials -- petroleum, coal, uranium, etc.
 (c) Manufacturing and transportation companies which use energy.
 (d) Consumer's demands for various products from (c) above.

 Consumer cards show market's demands for each of (c) above. The goal is to make more money. Each player in turn has the choice of buying the upturned card on each stack from 1-3 or skipping the opportunity. Those who have cards of raw materials and utilities will make conservative fixed amounts of money by selling to other players. Those who are in manufacturing or transportation will make much or little money depending on uncertainty of card turned up in demand pile (d).

 The turns are taken in sequence; luck depends on shuffled sequence of consumers' demands.

 There is an advantage to owning raw material and related utility and related manufacturing.

 The profit is kept by same player.

 If certain consumptions of raw materials reach fixed amounts, all players must pay the "bank" for pollution.

 Special pollution piles against specific industries or transportation neglects will be made once each to add pollution control devices. These cards will be scattered among consumer cards. (Scientific Objective B)

48. The student will pretend he is in the business of making coke from coal for the manufacture of steel. What wastes will result from this process? Could these wastes be used in a profitable manner to manufacture a by-product or could they be used in some effective way. (Scientific Objective D)

49. The city council is meeting to hear the reasons for replacing electric trolleys with diesel buses. The student will prepare a speech which will examine the benefits of each side. (Scientific Objective H)

50. The student will prepare a bar graph showing annual waste-product production by oil-fired, coal-fired, gas-fired and nuclear-fired electric generating plants. (Scientific Objective J)

51. The student will contrast the economic and environmental impacts of pipeline transport of coal, oil and gas to truck, and rail and ship. (Scientific Objective G)

52. The student will describe three major methods of transporting petroleum products. Compare the environmental impact of each. (Scientific Objective G)

53. The student will conduct activities with a transformer to see how voltage and amperage may be changed. Meters are needed. The Intermediate Science Curriculum St: · has suggested exercises for Level I (7th Grade). Danon Scientific make .ie relatively inexpensive meters. (Scientific Objective G)

54. The student will collect material from newspapers, files, magazines and testimony before congressional committees about the controversy over the method of delivering oil from the Alaskan oil fields. Debate the merits of suggested methods. (Scientific Objective G)

55. The student will select a major energy source and examine the transportation of that energy by visiting the actual sites of such transmission. Determine the costs (environmental, economic, resource use and waste) of the transmission and compare findings with those of other members of the class. (Scientific Objective K)

56. The student will secure a one-line diagram from a local utility. Trace the path the energy flows from its source of generation to the supplier or substation which supplies your home or school. Are there ways in which this route could be improved? (Scientific Objective M)

57. The student will ask a local utility for a copy of its annual report. The report has a statistical section detailing number of customers by class, energy sales by class, energy lost and unaccounted for, and total energy requirements for the system. Calculate the percent of total sales each class accounted for. If available for a number of years, this data could be graphed. What can be reported from such information? (Scientific Objective M)

ETHICAL OBJECTIVE ACTIVITIES

58. Organize a panel to discuss these issues: Should mankind consume petroleum as a source of chemicals to produce synthetic materials?

    Who should make the control decisions on that issue? What are the alternatives? Should we also be concerned about the energy needed to produce natural materials (such as wool and cotton)? (Ethical Objective A)

59. The student will construct a model city council in class and then testify before that body about the need for ordinances which will control the construction and abandonment of gas stations. (Ethical Objective C)

60. What advantages might be derived from more equalization of income and consumption relative to production and resources. What should be the responsibilities of each nation in terms of population control, resource consumption and income sharing?

61. Should limitations be placed on uses of energy, land and natural and processed resources? What should those limitations be? What type of agency should have that regulatory power? (Ethical Objective D)

62. If a nuclear power plant were to dispose of its heat wastes into the Columbia River so as to raise the average temperature of the river 5 degrees, what kinds of aquatic life would be affected and how? Construct a model of a modified food chain showing the interrelationship that would be altered. (Ethical Objective E)

63. A nuclear generating plant must have a portion of its used fuel reprocessed every year. This is done at established commercial companies in several states. The student will recommend means of transportation, waste-disposal methods, security measures and other considerations for the public's protection.

64. Three elements of the "good life" are:

(a) Desirability of work and school environments.
(b) Desirability of home environment.
(c) Desirability of recreational environment.

1. The student will list all energy-consuming devices needed for each environment and for transportation to each environment
2. Describe the location in terms of the most desirable climate, landscape and population.
3. If a model city were to be built, locate it on a map. Could energy be transferred there, reasonably, from present sources?

(Ethical Objective E)

AESTHETIC OBJECTIVE ACTIVITIES

65. The student will go to an art gallery and conduct an inventory of art objects which depict energy conversion. Explain the energy conversion being illustrated and attempt to hypothesize the original influence on the artist. (Aesthetic Objective A)

66. The student will formulate a series of lapel buttons with slogans designed to inform people about the aesthetic qualities of energy-conversion devices. (Aesthetic Objective A)

67. The student will refer to the drawing of the nuclear power plant cooling tower in Appendix of this Activity Guide.

    Are clouds more acceptable than tall towers?

    Observe the changes in the temperature of water from drawing in Appendix:

    (a) nuclear power plants
    (b) hydroelectric plants
    (c) fossil-fuel plants

    Do these change life in the water? In what ways? (Aesthetic Objective D)

68. The student will select an art object, preferably sculpture, and determine the kinds of energy used to produce it.

    Estimate the amount of energy used by the artist. Use calorie charts to determine the energy for a man at work. (Aesthetic Objective F)

UTILITARIAN OBJECTIVE ACTIVITIES

69. The student will pretend he is Secretary of the Interior and must decide on the best location for an oil pipeline from Bellingham to the rest of the state. Locate the line and defend the choice, aesthetically, environmentally, economically, politically. (Utilitarian Objective B)

70. The student will construct a description of each member of an idealized five member panel that must make ultimate decisions about the control of energy production. Include data that reveals:

    (a) political affinity
    (b) educational background
    (c) vocational background
    (d) ethical standards, etc.
    (Utilitarian Objective E)

71. The student will list the jobs created in a community by the building of:

    (a) a coal-fired electric power plant
    (b) an oil-fired electric power plant
    (c) a gas-fired electric power plant
    (d) a nuclear-fired electric power plant

    List the jobs displaced by such construction.
    (Utilitarian Objective F)

SCIENTIFIC OBJECTIVE ACTIVITIES

72. The student will examine the wastes which result from various energy conversion processes. Measure the efficiency of different machines. Describe the waste produced by the internal-combustion engine. (Scientific Objective D)

73. The student will make a list of the relative costs of energy transported by different means. Compare it with a printed table of such information.

    Calculate differences if changes were made.
    Calculate possible pollution "costs" and try to come up with solutions.
    Calculate possible savings to the community.
    (Scientific Objective K)

74. The student will obtain copies of laws in his state that deal with the control of vehicle emission systems. Analyze this information as to how it limits, protects, or provides opportunities for him personally in terms of:

    (a) economic benefits
    (b) personal liability
    (c) personal convenience
    (d) health standards

    Project these limits or opportunities five years in the future. How might these affect a career choice? (Ethical Objective C)

75. The student will refer to tables describing average annual income, energy consumption, and population. Calculate averages if all nations are grouped, if industrial nations are grouped, if Common Market countries are grouped, if underdeveloped nations are grouped, etc. Ethical Objective D)

UTILITARIAN OBJECTIVE ACTIVITIES

76. A "traditional value" in this country has been that if something works, it has to be good. What would happen if that value were reworded so that it was "the value of a process or product must be to create the greatest social good?" What implication would this have for policy-makers? How would it affect the growth of some industries? (Utilitarian Objective A)

77. What economic, environmental and other factors encourage the use of liquefied natural gas in Japan? Why is it not imported to other large energy-using countries? (Utilitarian Objective B)

78. The student will read each "siting" problem. Then under the "jurisdiction" columns place one of the following codes to indicate which agency should have jurisdiction for each problem.

0 - no jurisdiction
1 - primary (major) jurisdiction
2 - secondary (minor) jurisdiction
c - coordinate with, as a means for information, but not as a policy determiner.

Give reasons for the choices. Include the economic, transportation, environmental and social factors. (Utilitarian Objective E)

JURISDICTIONS

Other	Private	Federal	State	Regional or local	Problems of Siting
					INDUSTRIAL COMPLEX
					"HEAVY INDUSTRY"
					"LIGHT INDUSTRY"
					FOSSIL POWER PLANTS
					NUCLEAR POWER PLANTS
					MINERAL MINES
					COAL MINES
					OIL WELLS
					NEW CITIES
					PORTS
					STRIP MINES
					GRAVEL PIT

79. Energy production is affected by many agencies at the private, federal, state and local levels. The student will locate the names of the agencies at each level and determine their duties and legal status.

Do the public and private groups have disagreements in the determination of energy-production policies? Do they reconcile them? If so, how? If not, why not, and how might they? (Utilitarian Objective E)

ENERGY & MAN'S ENVIRONMENT

Chapter IV

ENVIRONMENTAL IMPACT OF ENERGY SOURCES AND USES

GOAL: The student will understand how energy production modifies the environment.

SCIENTIFIC OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

None

MIDDLE AND JUNIOR HIGH

A. The student will state the required location for each power plant:

1. plant burning coal
2. plant burning oil
3. plant burning natural gas
4. hydroelectric
5. nuclear
6. geothermal
7. tidal
8. solar cells

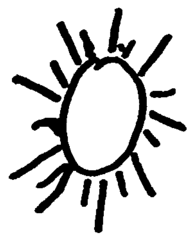
B. The student will describe the pollution generated as a by-product from each type of power plant.

C. The student will contrast pollution from power plants with pollution from:

1. transportation: auto, diesel, jet
2. manufacturing: iron and steel, paper and pulp mills, smelters

D. The student will describe the harmful or beneficial effects of each of the following:

1. in air
    a. CO
    b. CO_2 (global effect on weather)
    c. NO, O_3
    d. PAN
    e. SO_2
    f. particles
    g. lead oxide
2. water
    a. petroleum
    b. pesticides
    c. mercury
    d. cadium
    e. copper
    f. lead
    g. garbage
    h. acids
    i. soap
    j. mine wastes
3. thermal
    a. bacteria
    b. algae
    c. fish
    d. oysters
    e. crabs, lobsters
4. radioactive wastes
5. solid wastes
    a. mine tailings
    b. overburden from strip mining
    c. transportation of solid wastes
6. noise
7. visual (road signs, etc.)



SECONDARY AND SENIOR HIGH

E. The student will state ways energy can reduce pollution:

1. cottrell precipitators
2. recycling
3. devices on autos

ETHICAL OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

A. The student will compare at least three of the advantages and disadvantages, in terms of pollution, of home heating with oil, natural gas and electricity.

B. The student will describe six things he can do to reduce the need for additional energy in his life.

MIDDLE AND JUNIOR HIGH

C. The student will define the rights of each individual to power resources.

SECONDARY AND SENIOR HIGH

D. The student will describe appropriate recycling laws.

AESTHETIC OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

A. The student will describe four ways energy can be used to beautify surroundings, e.g. , to move water to support life, etc.

B. The student will describe three types of recycling which reduce littering.

MIDDLE AND JUNIOR HIGH

C. The student will list three ways a sewage treatment plant improves the environment.

SECONDARY AND SENIOR HIGH

D. The student will describe how air pollutants destroy the beauty of the environment.

UTILITARIAN OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

None

MIDDLE AND JUNIOR HIGH

A. The student will list the costs of pollution for:

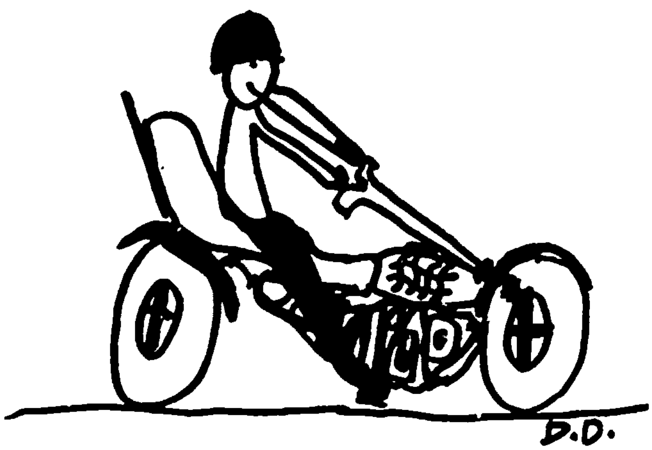
1. air pollutants on material
2. health reduced by CO, PAN

B. The student will list jobs needed to do the research for pollution control.

C. The student will list jobs needed to monitor and control pollution.

SECONDARY AND SENIOR HIGH

None



ENVIRONMENTAL IMPACT ACTIVITIES

PRIMARY GRADES

SCIENTIFIC OBJECTIVE ACTIVITIES

1. The student will visit a busy freeway, pedestrian overpass or bridge or business which is mechanized. Note the noise level before going to the point where the noise is loudest. Stay there several minutes. During this time, record the noise on a tape recorder.

   Return to area with an acceptable noise level. What are some noticeable differences?

   What are the effects upon society from noise pollution?

   Listen to the tape recording later at school. Try to identify the sounds. What solutions can be suggested for reducing or eliminating some of the noise?

   If this were a freeway, what does this suggest about the placement of multi-laned roads in our society? Do these highways infringe on people's rights?

   Teacher's Instructions: Administer an assignment with quiet, with music and with noise. Ask for student reactions. (Scientific Objective D)

INTERMEDIATE GRADES

SCIENTIFIC OBJECTIVE ACTIVITIES

1. The student will take photographs of different scenes in the community. Show water pollution by oil and garbage and take photos of non-polluted areas for contrast. The photographs might be made into slides, and a slide show prepared accompanied by student commentary. (Scientific Objectives A,D,G)

2. The student will obtain the pollution index from a local newspaper. Use a line graph and plot the pollution for a period of three or four weeks.

   Along with the pollution chart, keep charts of daily temperature and wind velocity.

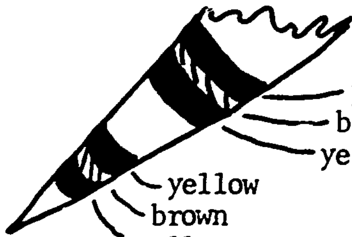
   Is there a correlation among temperature, wind velocity, day of the week, and percentage of air pollution? If so, why?

From this information, what can be said about the leading contributors of air pollution? (Scientific Objective C)

3. The student will take a sheet of glass or cardboard about 3" x 3". On the surface put masking tape with the sticky side up. Locate the plates at various places indoors and outdoors where the air is suspected to be clear and where it is suspected to be polluted. After several days, collect the sheets and examine what has collected there. (Scientific Objective D)

4. The student will prepare six 3" x 4" cardboards heavily coated with vaseline. Go to the school parking lot. Choose large, small, old and new models of cars. Include one with a pollution device, if possible. Having obtained the permission of the car owner, start the car's engine and collect exhaust emissions on the cardboard by holding the cards directly behind the exhaust pipe. Record the year and make of car on the cardboard. Be sure to run each engine for the same length of time. Compare the cardboards and discuss the findings. (Scientific Objective C)

5. The student will collect young white pine needles from several areas and examine them for evidence of damage by sulfur dioxide. Damage is indicated by discolored bands on the needles.



If the damage appears significant, plot the geographic areas where the worst needles came from and attempt to determine why the damage has occurred in those areas. (Scientific Objective C)

6. The student will visit a small stream or pond. Using a water testing kit, make the following tests--temperature, CO_2, SO_2, pH. Using the charts in <u>Field Study Manual for Outdoor Learning</u> by Milliken Hamer and McDonald, predict what life will be found in the stream or pond.

With a small collecting bottle (clean, old plastic medicine bottles are excellent), collect specimens from the stream or pond. Compare these specimens for temperature, CO_2, SO_2, and pH.

Now set up a hypothetical case in which one of the factors is varied (increased or decreased by some means) and try to predict what will happen to stream life.

Later, visit and test a lake, pond or stream along which there are many residents or businesses. Make the same tests and record the results. What are the results? (Scientific Objective D)

7. The student will obtain several pieces of clean cheesecloth and prepare a set of frames, made from wire or wood strips. Place these cheesecloth "pollution" gatherers in different locations which have single sources of possible air pollution. For example:

   a. (1) Near a freeway.
      (2) In fixed intervals from a smokestack e.g., 100 yards, 200 yards 400 yards, 800 yards.
      (3) Near a gravel pit.
      (4) Near a dusty dirt road.

   b. Compare the color changes observed from each site. Try observing your cloths under a microscope.

   c. What impact would each of the following variables have on the experiment?

      (1) Use of differing sizes of cheesecloth.
      (2) Distance from the ground.
      (3) Length of time for exposure.
      (4) Prevailing wind direction.
      (5) Multiple effects (freeway located near industrial smokestack).
      (6) Time of day.
      (7) Time of year.
      (8) Any others?

   d. How could this experiment be improved so that the variable of gathering the pollutant could be made more precise? (Scientific Objectives A,B)

8. The student will tour the power generating plant that supplies his city. Determine whether this is the best site on the basis of power source, transmission line length, impact on the immediate environment, impact on the city's environment. (Scientific Objectives A,B)

9. Ask a local doctor to visit the class and tell about the physical damage that results from air and water pollution. (Scientific Objective D)

10. The student will visit a bottling plant and find out what the company is doing about recycling. Discuss methods and costs of recycling in contrast to throwaway containers. (Scientific Objective E)

ETHICAL OBJECTIVE ACTIVITIES

11. The student will study some magazine advertisements about energy and power. Then formulate advertisements that reflect the point of view of the:

    a. Power producer
    b. Environmentalist
    c. Old mother earth
    d. Manufacturers' association that asks for a personal commitment by citizens to reduce the need for additional energy in his life.

    Present the advertisements to the class or PTA and ask for reactions from the audience. (Ethical Objective B)

12. The student will pretend that a major disaster has hit the community. Sources of electric power and water have been damaged. Describe the activities of the student's family under these circumstances. Underline each activity that is normally performed by power e.g., chopping and burning wood for heat, purifying water, etc. (Ethical Objective A)

13. Have all sources of power to the classroom turned off. Discuss those sources which are absolutely necessary to the school. Discuss alternate sources which contribute less pollution that might be substituted for those presently in use. (Ethical Objective C)

AESTHETIC OBJECTIVE ACTIVITIES

14. Using a noise level meter (either decibel meter or recording-level meter on a tape recorder), check the noise level at various places in the community--downtown street level, lunchroom, gymnasium, freeway, racetrack or dragstrip, department store, train, industrial shop, park, backyard, office interior. (Aesthetic Objective A)

15. The student will describe what constitutes objectionable noise. Consider decibel levels, frequencies, variation, etc. (Aesthetic Objective A)

16. The student will ask the custodian in the school building to describe the economic effects of pollution upon the building. Discuss with him how it has increased his work and how that problem might be alleviated. (Aesthetic Objective D)

17. The student will construct a compost pile from school-lunch garbage. What are the advantages and disadvantages of the compost pile? Can compost be used as a source of heat?

18. The student will discuss the appearance of vegetable gardens in the yards of homes. Should such gardens be in the front yard? Do such gardens have advantages over ornamental gardens?

MIDDLE AND JUNIOR HIGH

SCIENTIFIC OBJECTIVE ACTIVITIES

19. Have a mock discussion of location requirements for a power plant. Choose board of directors; representatives of transportation, labor, city and state government, environment-protection board, etc. (Scientific Objective A)

20. The student will visit an electric generating plant and ask these questions:

    a. Why was plant built here?
    b. Could it have been built at a different location?
    c. What is its source of fuel?
    d. Where, if fossil fuel, does the fuel come from?
    e. How is air pollution controlled?
    (Scientific Objective A)

21. The student will write the state Environmental Protection Agency and ask for laws regulating power plants, manufacturers, trucks, autos and planes. Compare the laws. Try to determine whether the laws are written fairly. (Scientific Objective C)

22.

TABLE 1

U.S. Air Pollutant Emissions, 1965

Source of Air Pollution	Millions of Tons	Percent of Total
Automobile	86	60%
Industry	23	17%
Electric Power Plant	20	14%
Space Heating	8	6%
Refuse Disposal	5	3%
Total	142	100%

Source: "The Sources of Air Pollution and Their Control," U.S. Public Health Service Publication, No. 1548, Washington, D.C.: U.S. Government Printing Office, 1966.

Using Table 1 as a source of data, the student will respond to the following questions:

a. Which source is the single greatest contributor to air pollution?

b. How does air pollution of all autos compare to the total of air pollutants contributed by industry, cluster power plants, space heating and refuse disposal?

c. If a railroad "coal" car could hold a load of about 50 tons, how many railroad cars full of pollutants were put into the air in 1965?

Fun math question: If a railroad car were 50 feet long, how long a train would be necessary to carry all the air pollutants? (Scientific Objective C)

23. The student will test exhaust emissions from a model airplane gasoline engine; choke the engine in order to produce emissions with higher concentrations of pollutants. Collect the emission gases by attaching tubing from the exhaust outlet to a large plastic bag. Make all connections air-tight by using tape if necessary.

The tubing should run through a bowl containing ice and salt. This will trap moisture so various pollutants can be detected.

a. For SO_2
Use potassium permanganate ($KMnO_4$) 0.25g per liter of distilled water. SO_2 will decolorize the dark purple solution.

b. Lead
Use a solution of 20 ml of water, 10 ml of concentrated acetic acid and 10g of chromic anhydride ($CR\ O_3$). The amount of yellow precipitate of lead chromate formed is a measure of lead compound in the gas.

c. For CO
Use half of a supply of beef blood to receive the bagful of exhaust emissions. Note the difference in colors. Carbon moxoxy-hemoglobin forms a darker color than oxy-hemoglobin.

d. For CO_2
Pass gas through lime water solution, $Ca\ (OH)_2$. The white sediment formed is $CaCO_3$, limestone.
(Scientific Objective D)

24. Water Pollution:

Use water and yeast (or sewage) to demonstrate biochemical oxygen demand (B.O.D.).

Pour 3 ml of milk into a cup containing 20 ml of water. Add 1 level teaspoon of dry yeast to a second cup containing 20 ml of water. Stir thoroughly.

Use methylene blue to indicate the presence of oxygen. If oxygen is consumed, the indicator becomes colorless.

Milk represents sewage and yeast represents decay organisms.

Using test tubes (or small cups) make various mixtures and observe changes. One half hour may be required before the yeast may be able to cause observable change.

Discuss how the food supply is related to organisms of decay. When oxygen is consumed, what happens to fish? (Scientific Objective D)

ETHICAL OBJECTIVE ACTIVITIES

25. The student will design and conduct a poll to find out how homeowners and residents of apartment houses feel about the advantages and disadvantages of heating with oil, natural gas, coal or electricity.

    Compile the results. What do they tell? (Ethical Objective A)

26. The student will:

    a. List the arguments favoring nuclear energy over other sources in or near population centers (so that the excess heat produced by the plant can be used by the community).

    b. List the arguments why a nuclear energy power plant should not be located near a population center.

       (Teacher's Instruction: A debate on this issue is plausible.)

    c. List ways of using to advantage the waste heat produced by power-generating plants.

    d. Calculate the amount of energy each world individual would receive per day if the daily energy consumption were divided evenly. Compare this with the amount now being used. How could each individual alter his energy use to bring himself into balance? (Ethical Objective B)

27. Simulation Game: design a court case.

    An underdeveloped nation sends a boy from a primitive tribe to ask the world court for his share of the world's energy.

    Participants:

    a. Judge
    b. Boy from underdeveloped nation
    c. Witnesses
       (1) United Nations representative
       (2) U.S. Department of Public Health
       (3) Mother of boy from U.S.
       (4) Mother of boy from underdeveloped nation

d. Lawyers (2)
e. Jury (5-man)
f. Defendant (boy from U.S.)

Be sure to include descriptions and quantify the natural resources involved in providing energy for the American boy. And be sure to note ways in which he consumes energy which are not obvious. (Ethical Objective C)

AESTHETIC OBJECTIVE ACTIVITIES

28. The student will visit a sewage-treatment plant. Try to find answers to these questions:

Yes	No	Undecided	
			a. Is the waste-treatment plant primary?
			b. Is the waste-treatment plant secondary?
			c. Is the waste-treatment plant tertiary?
			d. Do industries dump wastes into the community treatment plant?
			e. Do industries dump untreated wastes into local water sources?
			f. Do industries bypass the community's waste treatment?
			g. Do homeowners dump untreated wastes into local water sources?
			h. Is some waste bypassed into local water sources during normal dry weather? a. What percent _____ b. How often? _____
			i. In wet weather, when lines and plants may be filled by storm flow, is some sewage bypassed into water sources? a. What percent?_____ b. How often? _____
			j. Does the waste-treatment plant have enough employees to operate it efficiently on a 24-hour basis?
			k. Does the waste-treatment plant have enough employees to operate it efficiently on a 365-day basis?
			l. Is a training program provided for waste-treatment operators in the community?
			m. Does the waste-treatment plant provide on-the-job training?

Yes	No	Undecided

n. Is the training program paid for by the community?

o. Is the treatment plant up to date?

p. Does the community require connection to a public waste-treatment plant? a. How many sewer pipes are not connected to a waste-treatment plant?

q. Does the community prohibit its sewer system to be connected with storm water drains?

r. Does the community have a sewage-treatment problem?

s. Is the community informed about sewage-treatment problems?

From this information, what action should be taken? (Aesthetic Objective C)

UTILITARIAN OBJECTIVE ACTIVITIES

29. The student will write an advertisement designed to persuade the public that environmentalists are responsible for the nation's energy crisis. State a rule for including slant, bias, inaccurate information and unfair economic implications in such an ad. (Utilitarian Objective A)

30. The student will write the Superintendent of Documents for the series of pamphlets called Employment Outlook. Study the careers in pollution control and list what should be their educational requirements. (Utilitarian Objectives B,C)

31. The student will visit a pulp and paper plant and discuss methods of trapping possible pollutants and how these materials are either used or disposed. (Utilitarian Objective C)

32. The student will make his own soap. (Caution: Lye is dangerous.)

Dissolve a 13-ounce can of ordinary household lye in more than a quart of cold water. Do not use an aluminum vessel.

Melt 6 pounds of clean fat in a large beaker. Pour lye into the fat solution. Mix very slowly. Stir for 30 minutes or more. (Caution: lye is dangerous.)

Pour out soap slowly into molds and allow to harden for one week.

Compare the cost of this soap to the soap bought from the store. What are the advantages and disadvantages of making one's own soap?

33. Aquatic Studies Game*

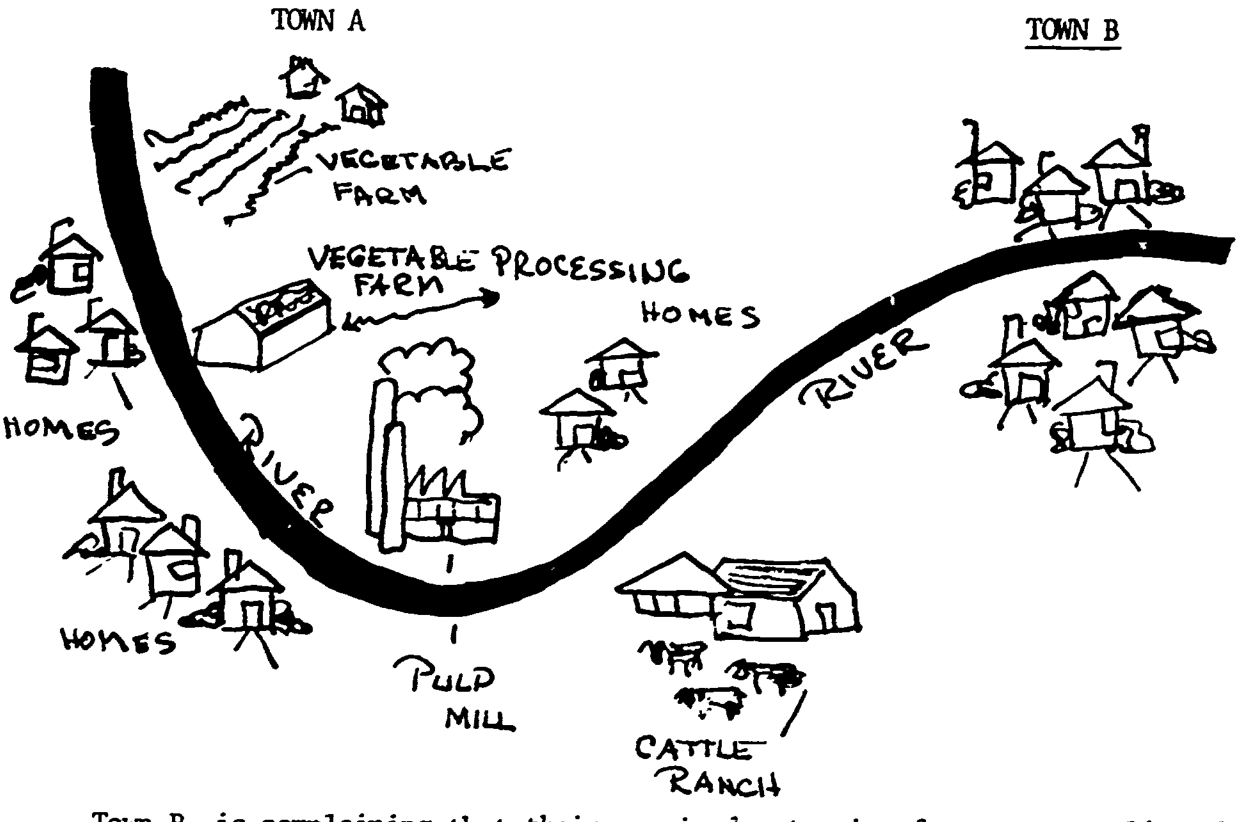
1. ACTIVITY: Financing

PURPOSE: To help students determine who is responsible for treatment financing

MATERIALS: None

PROCEDURE: Describe a typical town to the class, including industries, farms, and processing, residential areas, rivers and or lakes, etc. Present a situation of rising pollution and population and the need for better treatment of water.

For example:



Town B is complaining that their received water is of a poorer quality than that water received by Town A (same river). Town A realizes the need to purify their used water, but cannot decide how to finance a treatment plant. Role play town positions: mayor, cattle rancher, vegetable farmer, owner of processing plant, owner of pulp mill and towns people. Let the group of students that represent these positions determine who should pay.

*Taken from Aquatic Studies by "Tim" Smith KCTS - TV

"DIRTYWATER"

(A game designed to encourage students to become aware of decision making problems concerning a community's sewage treatment system)

Welcome to the community of "Dirtywater"!!! The purpose of this game is to create a new city known as "Cleanwater." You will begin by recognizing that your community, "Dirtywater", has a sewage treatment problem. You must act or face an ecological disaster.

OBJECTIVES:

a. To develop alternative strategies in community planning as they relate to the improvement of a water supply.

b. To express through discussion and debate the economic implications of decision making.

c. To develop attitudes through role playing techniques in an attempt to achieve effective changes.

PREPARATIONS:

a. Using arbitrary figures established by your group or class, prepare a map reflecting your version of "Dirtywater" that shows:

   (1) Boundary lines of your sewer district.
   (2) Existing and proposed recreational-use boundary lines.
   (3) Existing and proposed residential-use areas within your boundary lines.
   (4) Streams, lakes, and other bodies of water showing the location and direction of flow of major streams.
   (5) Public water source showing the location of wells and other sources of public water supply, water storage reservoirs, and other structures relating to public water sources.
   (6) Sewage treatment system showing the extent of the area included in your community and description (i.e.: drawing of current disposal system).
   (7) If desired, the topography of the community, showing pertinent ground elevations.

b. Again using arbitrary figures, decide the kinds of industries, businesses, etc., that are located in "Dirtywater" and their expected rate of growth.

c. Set the size of "Dirtywater's" population and its estimated rate of growth.

PROCEDURE:

Divide the class into groups of reasonable size and allow them to represent the various segments of the community. One group should represent the mayor; another, the city water commission; another group represents the homeowners of the community; and another, the city council. Remaining groups should represent the various types of industry and business that are located in the community. Try to include a few that rely heavily on water, such as a food processing company, pulp mill or a nuclear plant.

Because "Dirtywater" is faced with a sewage treatment concern, a variety of problems are presented to the community, to be faced by the community, one at a time. For example, the first class interaction with role playing might be to answer the question: how should the sewage treatment plant be financed? The different groups reflecting their position, representing the various roles in the community, must respond to this question and attempt to answer it. The mayor's group for instance might feel that the funds should come through increased taxation. The homeowners might definitely oppose such a measure because they feel the pulp mill in town pollutes the water more than they do. They suggest that the industries finance the new treatment plant. Obviously, the alternatives and possible solutions are endless and should stimulate further questioning, discussion and research.

PRESSURE POINTS:

A variety of pressure points or restrictions to alter the direction of the game might prove intriguing. The groups could think of such measures and impose them on each other. For example, the Water Commissioner's group might be restricted in their authority by not being able to control who can and cannot use the water, or the city budget group might be placed with a restriction for spending no more than ? number of dollars from their budget on sewage treatment. The possibilities are endless. The class might think of other ways to vary this activity, like making a fate card out of 3" x 5" paper and a spinner. One side of the card is marked "support" and the other side is marked "oppose". The purpose would be to have a direction of choice imposed on them.

Finally, the groups must decide which solution is the best answer to each of the problems in their community and how it may be effectively carried out. When the problem of financing has been answered, for example, the groups are now ready to tackle a new problem, such as, training and management, size of plant (effectiveness) and location of plant.

NOTE:

Be sure to handle only one problem at a time to avoid confusion and also to allow the maximum effectiveness from each group. Hopefully, the students will begin to empathize with the decision-makers in their own community and realize the seriousness of the problems related to sewage treatment and water quality.

SCIENTIFIC OBJECTIVE ACTIVITIES

34. It is not always possible to construct an electrical energy-producing power plant in the most desirable location. The student will suppose his geographic area needs more electric energy. Establish a set of criteria (rules or standards that you would apply to judge the desirability or undesirability) that might be used in studying where to locate a plant.

    Include these elements in the criteria:

    a. Location of plant
    b. Prevailing wind direction
    c. Water sources
    d. Fuel sources
    e. Economic impact
    f. Environmental impact
    (Scientific Objective A)

35. a. The student will construct a design for the most effective, yet practical exhaust muffler for:

    (1) Trucks
    (2) Automobiles
    (3) Motorcycles
    (4) Lawnmowers
    (5) Outboard motors
    (6) Chainsaws

    b. Compare the design with the present equipment on these items.

    c. Compare for noise level the original equipment mufflers on automobiles and motorcycles with "replacement modifications" intended to produce improved performance or "better sound."
    (Scientific Objective D)

36. The student will investigate the relationship between temperature and population growth by setting up yeast cultures of uniform concentration. Place the cultures in areas of controlled temperatures such as a refrigerator, suspended in a thermostatically controlled aquarium or in an incubator. For several consecutive days measure the population density of the different cultures. Graph the data. (Scientific Objective D)

ETHICAL OBJECTIVE ACTIVITIES

37. The student will design a tax depletion allowance for industries and power producers that utilize geothermal steam power (or nuclear power, solar power, etc.). (Ethical Objective C)

AESTHETIC OBJECTIVE ACTIVITIES

38. The student will design and make drawings of a system that could use waste to heat and cool office buildings in his city. Assume the system will burn 360 tons a day of solid waste and allow for future expansion to burn 1500 tons a day. (Aesthetic Objective A)

ENERGY & MAN'S ENVIRONMENT

CHAPTER V

LIMITS OF THE EARTH

GOAL: The student will describe factors that limit the energy available to man for useful work.

The student will state examples that describe the earth as essentially a closed system and that its ability to provide energy resources is finite.

SCIENTIFIC OBJECTIVES

PRIMARY GRADES

A. The student will describe the components of an ecosystem.

B. The student will describe possible effects on ecosystems if man uses nonrenewable energy resources to realize the proper relationships between artificial systems, equilibrium systems, and systems undergoing repair on this planet.

C. The student will diagram a simple food chain and discuss the interdependence of the trophic levels. Discussion should include the flow of energy and nutrients through the system.

INTERMEDIATE GRADES

D. The student will describe the limits of the earth's energy resources.

E. The student will describe the rate at which energy is being used in the U.S.

F. The student will describe energy flow and entropy in an ecosystem.

G. The student will give examples of limits to exponential growth in a closed system including examples of nutrient cycling, space and energy sources.

H. The student will describe the physical effects on the ecosystem if energy were to be available to man on an unlimited scale.

I. The student will identify and describe the limits the growing system will meet next, assuming technological advances could remove some natural limits to energy resources.

J. The student shall be able to explain where to look geologically for fossil fuels. The discussion should include reasons why they are not found elsewhere.

K. The student shall discuss the limits to exponential population growth in a closed system. Included should be the limiting factors of available nutrients (food), atmosphere and suitable habitats (substrates for attached marine organisms to housing and medical care for people).

L. The student will contrast renewable and nonrenewable resources, including but not limited to fuel, minerals and other energy sources.

MIDDLE AND JUNIOR HIGH

M. The student will identify ways of extending the life of the crude oil supply. Basically, this is done by reducing consumption.

N. The student will draw an approximation of the world and U.S. coal cycles.

O. The student will formulate a policy that would more equally distribute the energy resources geographically in the world.

SECONDARY AND SENIOR HIGH

P. The student shall graph an approximation of the complete cycle of crude oil production for the U.S. and the world.

Q. The student will calculate the percentage of the world's oil, coal and natural gas owned by the U.S. and what percentage of the world's annual output we actually use.

ETHICAL OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

A. The student will describe the relationship between limited energy resources and international trade.

B. The student will describe the relationship of limited energy resources to social systems such as political, economic, and family.

C. The student will evaluate what is necessary to implement a policy based on unlimited energy.

MIDDLE AND JUNIOR HIGH

D. The student will list alternatives to our present rate of consumption of resources and explain why they could be acceptable.

E. The student will describe legal considerations of overcrowding.

F. The student will discuss the ethics of a group or individual that monopolizes a disproportionate share of a resource.

SECONDARY AND SENIOR HIGH

G. The student will give examples of the loss of freedom in our legal system as constraints are placed on energy use.

AESTHETIC OBJECTIVES

PRIMARY GRADES

A. The student will describe aesthetic impact on natural resources, e.g. recreation development, urbanization, mineral exploitation.

B. The student will describe why resources around centers of population often are depleted or overused.

INTERMEDIATE GRADES

C. The student will describe implications for the quality of life under severely restricted energy-resource conditions.

D. The student will relate the standard of living in a highly industrialized society to the prospect of further limits of available energy resources i.e., what will happen as resource competition grows?

E. The student will discuss how overcrowding can lead to psychological stress.

F. The student will describe the aesthetic aspects of mass production of animals in feedlots.

MIDDLE AND JUNIOR HIGH

G. The student will discuss how stress might lead to competition for the basics of existence, recreational facilities and educational facilities.

SECONDARY AND SENIOR HIGH

None

UTILITARIAN OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

A. The student will predict the kinds of jobs that would be eliminated if a more severe limit to energy resources were to occur.

B. The student will predict the kinds of jobs that would become available with the advent of severely limited energy resources.

C. The student will state five ways to make more efficient use of our energy sources.

MIDDLE AND JUNIOR HIGH

D. The student will compare the advantages and disadvantages of using fossil hydrocarbon resources as a base for synthetic production rather than as a fuel.

E. The student will discuss the merits of land-use planning to ease population pressure and to utilize energy resources more efficiently.

SECONDARY AND SENIOR HIGH

None

LIMITS OF THE EARTH ACTIVITIES

PRIMARY GRADES

AESTHETIC OBJECTIVE ACTIVITIES

1. The local stores have all announced that due to a transportation strike there will be no more candy bars for an extended period of time.

   What will happen to the present supply? How will the supply be distributed? Will there be restrictions as to how many bars each person will be permitted to buy? What will happen to the price? What will happen to you emotionally if there are no restrictions and someone ahead of you buys the last box of bars? What will you be willing to do to get some of those bars? (Aesthetic Objective D)

INTERMEDIATE GRADES

SCIENTIFIC OBJECTIVE ACTIVITIES

2. The amount of energy now available and usable on the earth is fixed and unknown. The student will diagram or sketch a chart which will illustrate what happens when there is a relative fixed amount of energy but increased use and demand for it. (Scientific Objective D)

3. The student will place, into a large glass jar which can be sealed, a goldfish, a few small snails, pond water and pond plants. What is necessary to make this ecosystem work? (Scientific Objective A)

4. The student will set up a second large jar containing pond water, snails and fish, but no plants. Seal the jar. Theorize what will happen in this system. Give reasons. Observe and record observations for several days. Was the theory substantiated by the results? Why did this occur? (Scientific Objective G)

5. An ecosystem is a discrete community of organisms consisting of organisms which are producers, consumers and decomposers. The student will identify an ecosystem on the school's property. Identify in the system organisms which perform each function.

   Probably the ecosystem being observed has been disturbed by man. Compare the present ecosystem with the pre-man ecosystem. What will happen if man is again eliminated from the system? (Scientific Objective A)

6. The student will note differences in energy flow by setting up several aquaria, each containing the same weight of living materials. The simplest aquarium may consist of a quart jar innoculated with algae and minerals.

(Teacher's instruction: Chlorella and Knopps Solution are suggested. Primary students may use pond water that is green.)

Place one aquarium in full sunlight during the day and under a lamp at night. Place another aquarium in the presence of sunlight only or lamp only. Place another aquarium in complete darkness. After several weeks note and record the differences. The intensity of the green color can show the difference in the quantity of life.

A quantitative measurement may be made by organizing a serial dilution series of a green food-coloring dye. Each solution is one-tenth the concentration of dye in water as the preceding solution. By comparing these defined standard solutions to the aquaria, the relative quantity of the algae may be estimated. Record and interpret the results.

Measure the quantity of energy absorbed. Light meters may be used to show the degree of intensity. Artificial sources of illumination should be used to control completely the energy sources.

Graph the relationship between quantity of energy and quantity of organisms. A weight of organisms may be obtained by centrifuging samples from each aquarium, decanting the supernatant liquid, and weighing the contents. (Scientific Objective F)

7. The student will raise a series of pea plants in sand. Add to the sands various concentrations of nutrient solutions. Compile and interpret the res·'ts.

(...her's instruction: elementary children may add soil and fertilizers. ...or-high students may carefully add measured salt solutions containing ni...ates, phosphates, etc. The addition of nitrate fertilizers often produces dramatic results in comparison to the control plants.) (Scientific Objective I)

8. Marine life is found in estuaries. The student will try these experiments to demonstrate this.

a. Allow muddy water to stand in a jar for several days. Gradually the silt will settle to the bottom. Relatively clear water will remain on the top. The silt from the bottom may be used to raise pea plants. Compare the growth of pea plants grown in sand, in silt derived from muddy water, and in topsoil from the local area.

b. The salt content of samples of water may be measured by observing the remaining salts after all of the water has been boiled away. Samples of naturally occuring waters may be used for observing the growth of algae in the water. Use a saltwater algae. Concentrations of algae may be measured. (Scientific Objective K)

9. The student will diagram the flow of energy in the hydrocycle by which the sun's energy creates the movement of water to the land sources of rivers, which may be used in transportation and may be converted to mechanical or electric energy. (Scientific Objective L)

10. Among the few renewable energy resources is wood fuel. However, abuse could quickly make it non-renewable. To prevent a total loss of wood as both an energy source and a building or shelter, public policy has required that national forests be harvested so that the forests can be renewed. Man has not always followed this policy. The student will attempt to discover which ancient and modern civilizations lost their forest resources. Discuss how the renewal of forest resources either helps or hinders individuals and societies. (Scientific Objective L)

ETHICAL OBJECTIVE ACTIVITIES

11. The student will describe his reactions if he were required to use public transit rather than driving his own automobile. (Ethical Objective G)

12. The student will evaluate the minimum amount of energy he would need for bare existence. (Ethical Objective G)

13. The student will list examples of restraints that might result from overpopulation. (Ethical Objective E)

14. The student will list services that would need to be instituted and those that would have to be abandoned, as a result of overcrowding. (Ethical Objective E)

AESTHETIC OBJECTIVE ACTIVITIES

15. The student will assume that a definite amount of energy is allotted to meet all his physical and psychological needs. Assume that amount of energy is about half which he presently consumes. How would he modify his lifestyle to conform to the energy available? (Aesthetic Objective C)

16. The student will interview the head of the school maintenance department. Obtain from him the cost of damage done to the school during the year. In which part of the school was the damage the greatest? Does this correlate to the number of people in that area? (Aesthetic Objective G)

17. The student will write to a nearby forest-service representative to find out the cost of damage done to camping areas, both in populated areas and in more remote areas. Obtain the numbers of persons using each camping area. Make graphs showing dollar amounts of damage in each area and numbers of persons using each area. What implications are there for the stress and competition for use in these areas? (Aesthetic Objective G)

18. The student will research the lifestyles of the Australian aborigines, the Eskimos and the Kalahari Desert tribes. What are their energy resources? What implications are there for us if we are faced with severely restricted energy resources? How would the student modify his lifestyle? Justify the choices. (Aesthetic Objective C)

19. A large animal feedlot may be constructed in the community. The student will prepare arguments as to why the feedlot should or should not be permitted, and what regulations should be imposed if the feedlot were constructed. (Aesthetic Objective F)

UTILITARIAN OBJECTIVE ACTIVITIES

20. When a resource becomes more scarce, the law of supply-and-demand forces up the price. When it is too expensive for most users, there is a shift to a replacement resource. The shift from oil and gas to coal for the generation of electric power is an example.

    Have the class list 10 of their favorite possessions that are made from oil or gas (synthetic fibers, plastics) and then discuss what might happen to the cost and availability of these items as oil and gas become less available.

21. When a resource begins to become scarce, it's due in part to the difficulty of finding it, taking it out of the ground, processing it for use, and transporting it to market. (Utilitarian Objective B)

    Pick an energy resource, oil for example, and discuss what jobs might be created or eliminated as it becomes more scarce; e.g. more jobs for geologists but fewer gas-station attendants.

22. The student will pick one favorite possession which is made of man-made material (plastic or synthetic fiber). Also, select a short motor trip he would like very much to take.

    Decide between the trip and the possession. Defend the choice on the basis of expenditure of fossil resources. The trip would take energy and fossil fuel, and so did manufacture of the possession. (Utilitarian Objective D)

23. From the following items, the student will list the energy consumed by each in its production and in its use. If the student had to cut his energy consumption drastically, which of these could he replace easily? Which would be more difficult? Which would be impossible?

Electric lighting	Prefab house
Electric cooking	Aluminum siding
Electric heat	Power lawn mower
Water heating	Steam shovel
Air conditioning	Electric toothbrush
Mixer	Power saw
Washer	Plastic modular furniture
Dryer	Dishwasher
Synthetic fiber clothing	Television
Wood frame house	Radio
Automobile	Stereo system
Stop lights	Road graders
Street lights	Tractors

(Utilitarian Objective C)

MIDDLE AND JUNIOR HIGH

SCIENTIFIC OBJECTIVE ACTIVITIES

24. On separate pie charts, the student will compare the consumption of oil, coal and other energy sources by industry, agriculture, government, etc. (Scientific Objective G)

25. Using the charts on page 111 of "The Biosphere", Scientific American, W. H. Freeman Co., 1970, the student will prepare a chart showing the probable duration of the use of coal, oil and natural gas if future use is at the 1970 rate; then at the year 2000 rate.

(Teacher's instruction: Refer to page 111, "The Biosphere" Scientific American, W. H. Freeman Co., 1970.
(Scientific Objective E)

26.

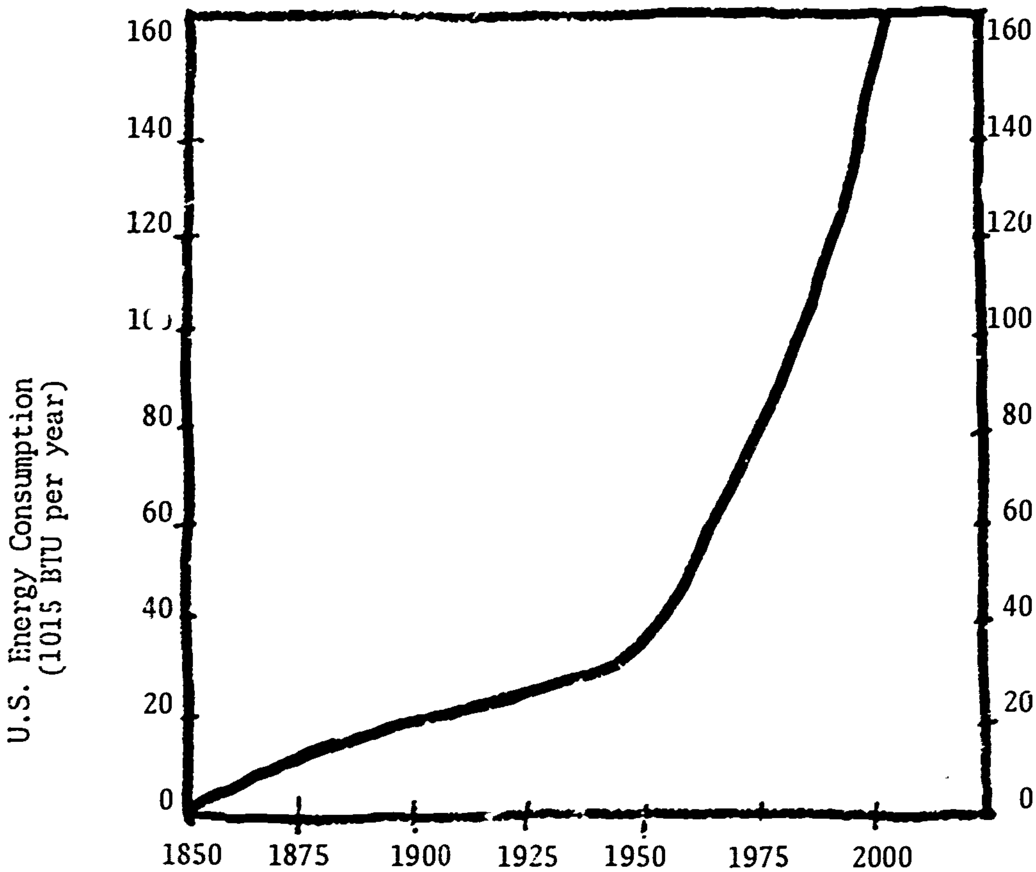


Figure 1 - U.S. Energy Consumption
(From U.S. Bureau of Mines)

Using the graph, respond to the following:

a. Select the year 1925 and compare the U.S. energy consumption that year with 1900 and 1950.
b. Compare 1975 to 1950.
c. How would you use the chart to find the energy consumption in 1960, 1970 and this year?
d. About which year was there a marked beginning of a great increase in energy consumption? How would you account for the increase then?
e. Check a book or source that presents the U.S. population for the year that you chose in No. 4. How do the two data correlate?
f. What will happen if we use energy at the predicted level beyond 1975 and also if all other people in the world were to achieve the same? (Scientific Objective G)

27. International wars often have been fought because one nation wanted more resources or energy. Review the wars of the world since 1900. Give examples of fighting motivated by the quest for resources. (Scientific Objective G)

28. Assume the earth had an unlimited supply of natural resources. Predict the world's population growth. (Scientific Objective H)

29. In nearly all geographic areas of the U.S. there are fish hatcheries. These hatcheries have been established as an artificial system to help re-establish fish life in lakes, ponds, streams and rivers. How do these hatcheries help keep fish from extinction and are they worth the cost to maintain? Do you feel this is the best way to proceed? Why? (Scientific Objective B)

30. The student will sketch the ideal geologic structure where coal, oil and gas are normally found. Indicate on a map of the world locations containing these formations. (Scientific Objective J)

31. The student will discuss why large reservoirs of oil are not likely to be found below the deeper depths of the ocean. (Scientific Objective J)

32. The student will observe fruit flies in a contained bottle. Make a population count each day. The supply of sugar will not be exhausted before the bottle is crowded with organisms and the population ceases to grow. (Scientific Objective K)

33. The student will study the flatworm <u>Planaria</u>. Planaria which are well-fed with liver increase in size and population. But planaria which are cut and forced to grow under adverse conditions flourish better than those which receive the best care. Those under the maximum care will tend to have a sudden collapse in population by disintegrating. Discuss genetic erosion, noting that ideal conditions do not favor the ultimate survival of the species. (Scientific Objective K)

ETHICAL OBJECTIVE ACTIVITIES

34. The student will assume the role of a representative to the United Nations. Argue before that body for a more equitable share of the world's resources.

35. The student will write down the rules to be used if he had to redistribute the resources of the world.

36. The student will contrast the immediate and long-term effects on the people of Saudi Arabia and Kuwait by the discovery and exploitation of oil in their countries.

37. Do all societies value technological advances? Discuss the ethics of forcing one's technological orientation on nations or societies which do not have it.

38. Discuss ramifications of the Middle East countries' refusing to sell oil resources to the United States. List five ways in which this would affect one's personal life. (Ethical Objective A)

39. Discuss the influence on world trade as an undeveloped, resource-rich nation moves toward greater development. (Ethical Objective A)

40. On a world map color those areas rich in mineral resources. On an overlay indicate the highly industrialized areas so the relationship can be noted. (Ethical Objective A)

41. Assume all energy resources were cut in half. The student will list the ways in which his local government would be affected. (Ethical Objective B)

42. The student will describe the changes that occur in political systems where resources diminish. (Ethical Objective B)

43. Have a debate on this topic: Resolved: Family structures change in response to limited energy resources. For example, what else is there to do if there isn't electricity for the television set? (Ethical Objective B)

44. The student will assume he is a Congressman. Write a law which would restrict fuel consumption and be equitable to all sectors of society. (Ethical Objective G)

45. The student will describe the governmental unit which should be responsible for determining the rules under which energy or fuel use might be rationed. (Ethical Objective G)

46. The student will set up the enforcement mechanisms necessary to accomplish orderly reductions in energy use. (Ethical Objective A)

AESTHETIC OBJECTIVE ACTIVITIES

47. a. Arrange the students in the class equidistant from one another all over the room. After three minutes, discuss their reactions to occupying the space allotted. Then have all of the students move into half the room, and after three minutes, discuss reactions. Keep halving the available space until about two square feet per student is reached. Discuss the problems of congestion due to overpopulation.

    b. Discuss the responses to the prospect of living continuously in the school situation, with its attendant human congestion. (Aesthetic Objective E)

48. Visit a planned-unit development. Talk to the developer and look at his plans. Discuss his use of land. How could it be done better? Would it be preferable to live in his planned-unit development, on a farm, or in an apartment? Defend your choice. Which is the best use of the land? (Aesthetic Objective E, Utilitarian Objective E)

49. Visit a gravel quarry and a cement plant in the area. Discuss the desirability of these operations being located near centers of population (cost, transportation, jobs, etc.). Discuss the conflicts that could occur between these operations and the expansion of the suburbs, other industrial operating, and agriculture. What effect does its presence have on the environment? (Aesthetic Objective B, Utilitarian Objective E)

50. Assume it is decided by our nation that the reproduction rate must be reduced to 50% of its present rate in order to assure enough resources to avoid the catastrophes attendant with too large a population for the energy available.

51. Construct a plan within the estrictions of our present social, governmental and legal systems to control the number of people. (Aesthetic Objective C)

UTILITARIAN OBJECTIVE ACTIVITIES

51. Assume that all machinery would be unusable because fuel or electric power was lacking. The student will list the jobs that would be created. Include manual labor for road building, more carpenters, service activities, weavers, etc. (Utilitarian Objective B)

52. The student will list the order in which jobs would be eliminated with the limiting of energy resources. Include computer occupations, manufacturing processes, research, power-generating-plant building, transmissionline building, maintenance, etc. (Utilitarian Objective A)

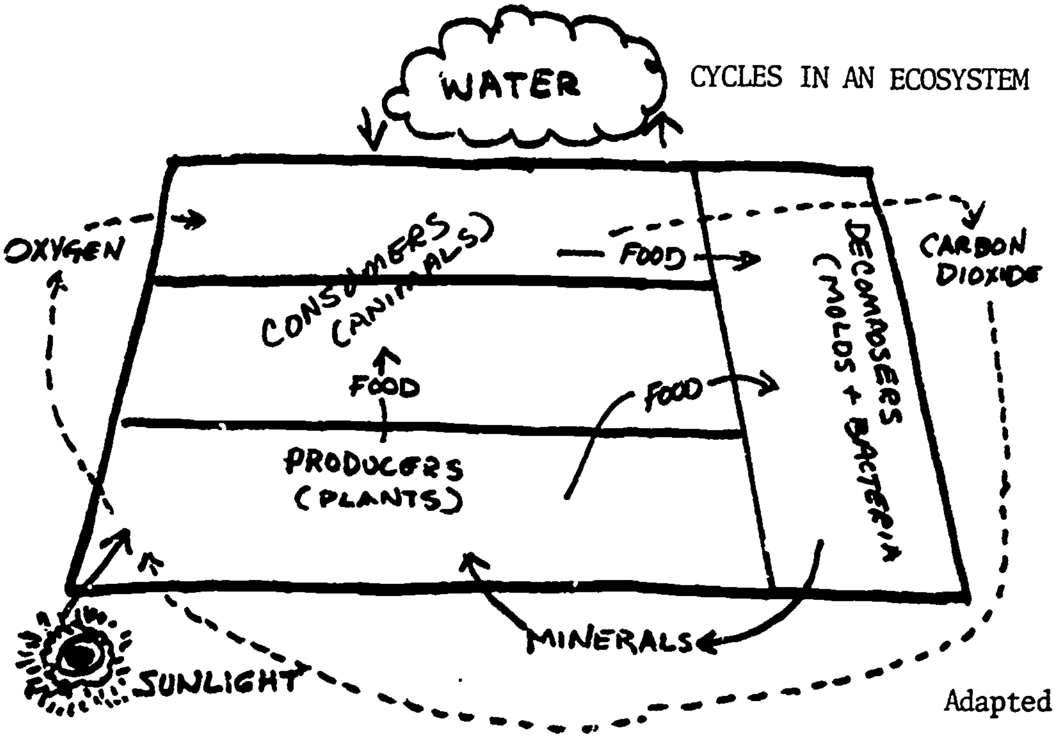
SECONDARY AND SENIOR HIGH

SCIENTIFIC OBJECTIVE ACTIVITIES

53. The question about energy reserve is not, "How long will energy last?", but "How long will energy serve as sources for mankind?" What does this mean, and what is your reaction? (Scientific Objective C)

54.

CYCLES IN AN ECOSYSTEM



Adapted from SCIS

UTILITARIAN OBJECTIVE ACTIVITIES

55. Assume that it becomes more important to feed available grains to people than to animals. Propose a plan for processing garbage to provide food for cows, sheep, pigs and chickens. List the new occupations that will result from this processing plan. (Utilitarian Objective B)

56. Assume that all oil deposits in the U.S. became exhausted. List the jobs that would be eliminated as a result. Discuss the implications for vocational planning.

57. List all the synthetic substances which use fossil fuels as the base substance necessary for their synthesis. Discuss the advisability of using those hydrocarbon fossil resources as fuels as opposed to using them for the manufacture of synthetics. (Utilitarian Objective D)

CHAPTER VI

FUTURE ENERGY SOURCES

GOAL: The student will describe new energy sources and more efficient systems utilizing present energy sources which have potential promise for helping to alleviate the world energy crisis.

SCIENTIFIC OBJECTIVES

PRIMARY GRADES

A. The student will describe potential sources of energy which are relatively unused today:

1. sewage
2. garbage
3. hydrogen
4. fusion
5. solar
6. animal manure
7. sound and noise waves
8. other

INTERMEDIATE GRADES

B. The student will describe more efficient use of heat that is relatively wasted today:

1. single-family dwellings into multiple units with central heat for the buildings
2. waste heat from a steam plant
3. public transportation
4. two-way telecommunication to replace transportation
5. hydrocarbc. generators turned off in off-season to make H_2 for fuel-cell use

MIDDLE AND JUNIOR HIGH

C. The student will describe the concepts of the fusion reaction of:

1. lasers
2. magnetic fields
3. H_2 to H_e (fusion reactions)
4. MHD

D. The student will describe the use of solar energy through reflectors, green-house effects, absorption, solar-energy cells.

E. The student will describe concepts of solar energy used by plants.

SECONDARY AND SENIOR HIGH

F. The student will describe the utilization of solar energy by an orbiting space collection system.

G. The student will describe the concepts of storing energy:

1. plants store sugar and starch
2. batteries store chemical energy
3. electrolysis can produce H_2 as a fuel which can be used directly in an energy cell to produce electricity with water as a waste or by-product.

ETHICAL OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

A. The student will describe the voters' responsibility to require systematic and practical municipal planning to utilize sewage and garbage for the most appropriate limiting of pollution and recycling of minerals, materials and energy.

MIDDLE AND JUNIOR HIGH

B. The student will describe responsibilities to conserve power through lifestyles which respect the needs of other persons. What must be changed? Can the changes be effected?

SECONDARY AND SENIOR HIGH

C. The student will describe the processes and organizations which would support basic scientific research and applied technological research regarding a better use of energy resources.

AESTHETIC OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

A. The student will describe the aesthetic advantages of advanced recycling systems, e.g., using sewage and garbage as opposed to present disposal methods.

B. The student will describe the most aesthetically acceptable forms of energy for efficient housing and transportation.

C. The student will describe appropriate noise-level standards which would apply to transportation pathways and housing developments.

MIDDLE AND JUNIOR HIGH

D. The student will describe the aesthetically best location for solar cells, solar reflectors, nuclear reactors to generate electricity, recycling centers.

SECONDARY AND SENIOR HIGH

E. The student will describe acceptable means of transmitting and storing energy. Include charged particles, laser, microwave and semiconductor transmission; also storing of hydro, fossil-fuel, chemical and nuclear energy.

F. The student will describe how our country could benefit by the reduction and ultimate ending of harmful pollution.

UTILITARIAN OBJECTIVES

PRIMARY GRADES

None

INTERMEDIATE GRADES

A. The student will evaluate the effect on the job market of a shift to non-disposable items.

B. The student will describe the changes in employment which are needed to introduce improved transportation and housing.

MIDDLE AND JUNIOR HIGH

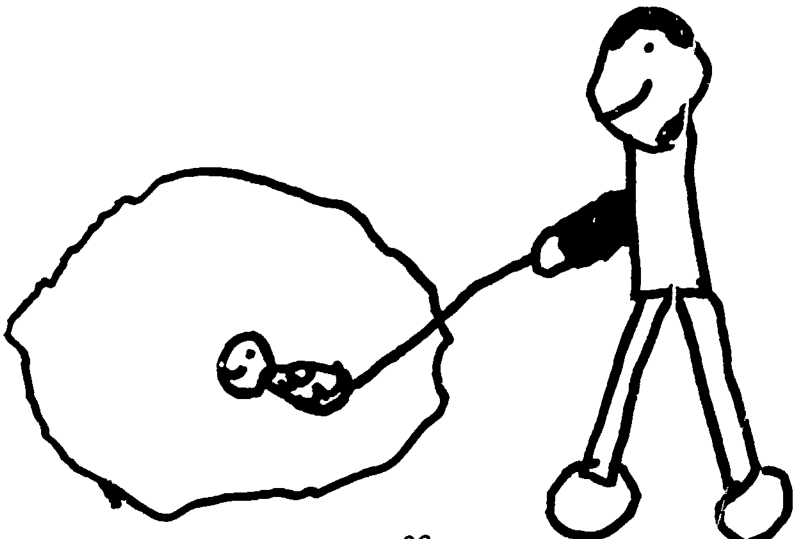
C. The student will describe economic advantages of pollution elimination through the conversion of by-products from wastes.

D. The student will describe scientific and technological research jobs which should be supported.

E. The student will evaluate the merits of garbage sorting versus total pickup, e.g., separation of fats, metals, bottles, bundles, and other materials, and the feasibility of it.

SECONDARY AND SENIOR HIGH

F. The student will describe alternative uses of hydrocarbons if alternative sources of energy are used.



FUTURE ENERGY SOURCES ACTIVITIES

PRIMARY GRADES

1. It has been suggested that through greater use of public transportation (buses, trains) private citizens would use less fuel in their cars. Suppose this were put into action. List the fuels that would be saved. Who might lose jobs? What jobs would be created? (Scientific Objective B)

2. The student will take two different trays of soil and plant some seeds. Over one of the trays place a clear plastic "roof". The roof may be made by making a coat-hanger wire frame and covering it with clear plastic.

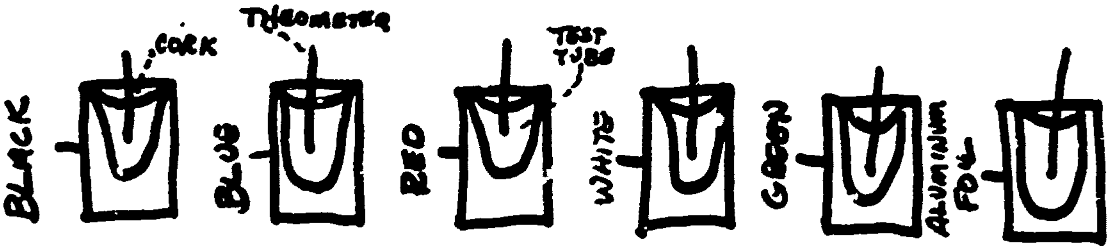
   Prepare a plant-growth chart and determine which tray will:

   a. sprout first
   b. have the fastest growing plants
   c. have the warmest "immediate environment." Why?
      (Scientific Objective D)

3. Visit a sanitary land-fill project in the area and list five items that might have been recycled, reused, or burned to produce heat. (Scientific Objective E)

INTERMEDIATE GRADES

4. Fill a series of corked test tubes into which a hole has been drilled and a thermometer inserted. Behind each test tube place a different sheet of colored paper. (Black, blue, red, white, green, foil).



   Record the temperature of each thermometer. Allow each to be exposed to the sunlight for five minutes. After the five minutes exposure, read the thermometer again and record the temperature. Are there any differences? Continue the experiment for thirty minutes, recording all temperatures every five minutes. What can be said about the color background and temperature change?

   Repeat the experiment by wrapping each tube completely by the colored item, and leave them wrapped for one-half hour after making an initial temperature reading. Are there any differences observable from the first set of data? Explain any differences.

What implications does this experiment have on solar energy? (Scientific Objective D)

5. The Astronauts use solar energy as a primary energy source when on the moon. The energy is provided by a conversion of the sun's solar energy to electric energy. This source has been suggested as an energy substitute for gasoline to provide power to autos. List some of the problems which would take place if autos were made to use solar energy? How could the problems be solved?

6. The student will raise bean plants until cotyledons are above the ground. Remove the cotyledons. Use aluminum foil to cover half of the leaves on each plant. After two weeks remove all the leaves. Dry both sets of leaves until they are completely dry e.g., by placing them in sunlight for a week.

   Weigh both sets or measure the area of both sets of leaves. Burn the leaves on a screen to demonstrate their use as a fuel. (Scientific Objective D)

ETHICAL OBJECTIVE ACTIVITIES

7. The student will describe the relationship between the local garbage disposal unit and the local government.

   Describe the disposal methods of solid waste in the community.

   Investigate alternative methods of waste disposal which have less negative environmental impact. (Ethical Objective A)

8. Investigate the apparent excessive use of lighting in commercial buildings at night and compare use with need. (Ethical Objective B)

9. The student will check with a local utility to determine the number of kwh used in October of the year before. He will ask his family to conserve electricity by all means possible for the month of October. Compare the kwh used for October of each year to determine the amount of savings. Provide for the variables of degree days, added energy-using devices added during the year, and daylight intensity. (Ethical Objective B)

10. The student will interview his parents concerning who makes the decisions about the purchase of major electric appliances. Ask what influences their selection of brand, size and model. Ask whether the amount of electricity required is considered. (Ethical Objective B)

11. The student will inventory his belongings and list those acquired during the past two years which use energy. List those things he would like to acquire. (Ethical Objective B)

12. The student will investigate the use of energy by a child in Japan and one in Greece. Is there a difference? Explain. Is there any correlation with population or population growth? (Ethical Objective B)

AESTHETIC OBJECTIVE ACTIVITIES

13. Having discussed future possible methods of using garbage and sewage as energy sources, suggest the most pleasing uses to which they might be put, e.g. fertilizer or soil conditioner for flowers, shrubs; food for pets and farm animals; Japanese use of garbage in building blocks.

    After discovering what solid substances remain as a result of composting treatment, suggest several uses to which this might be put that would be aesthetically gratifying. Try out your plan to see if it works. (Aesthetic Objective A)

14. The student will interview persons in his neighborhood concerning the effects noise has on them. Tabulate the results.

    Does noise cause:

	Yes	No
Fatigue		
Irritability		
Physical distress		
headache		
insomnia		
upset stomach		
Tension		
Hyper Activity		

    (Teacher's instruction: Refer to Sound Pollution, Breysse, p. 52-59.) (Aesthetic Objective C)

15. Divide children into groups and have each group design the best aesthetical location for one of the facilities listed. Each group must justify to the total class satisfaction their location and the development of these facilities. (Aesthetic Objective D)

16. Gather pictures of various ways energy is transmitted and stored. Project the pictures on a screen. Discuss them and decide which ones are acceptable. Justify their selection. (Aesthetic Objective E)

17. Within five minutes, list as many examples of pollution as possible. Tell what the benefits to mankind would be if they were eliminated. (Aesthetic Objective F)

UTILITARIAN OBJECTIVE ACTIVITIES

18. If it is true that some packaging is non-essential. and is thereby a wasteful use of natural resources (raw material and energy), what specific jobs would be affected by the elimination of excessive packaging?

    a. List jobs affected
    b. Determine whether an increase or decrease in the cost of the item would result
    c. What problems of shipping and storage would result?
    d. Itemize sanitary implications for ten grocery or drug-store items that are edible
    e. Explore other economic implications. (Utilitarian Objective A)

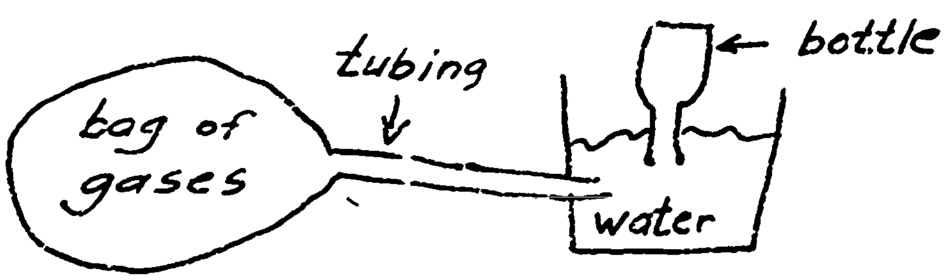
19. Discuss the jobs that would be affected and the sources of energy that would be made more available if the principle mode of transportation in a city were to change from private automobile to mass transit (buses, trains). (Utilitarian Objective B)

20. The student will construct a flow chart or mural illustrating the manufacture of a pollution-control device. Consider the jobs created and the energy and resources used. (Utilitarian Objective C)

21. Discuss how garbage utilities of the future might be able to cut costs by requiring the householder to separate cans, bottles and burnable trash. (Utilitarian Objective F)

MIDDLE AND JUNICR HIGH

22. Place an empty plastic bag over the top of a large quantity of wet garbage. Collect the gases which are generated. Empty the plastic bag through water displacement into inverted bottles.



After inverting the bottle in a tank or bucket of water remove to cap. The bottle should not exceed the size of a cup. Use a burning splint to test for combustability. Suggest ways to use this gas profitably. (Scientific Objective A)

23. Demonstrate a chain reaction using ping pong balls and many mouse traps. Relate it to fission reaction. Explain how it should be done. (Scientific Objective A)

24. Heat sugar on a piece of aluminum foil to demonstrate one compound giving off energy as it decomposes. Note how the water bubbles and boils off, leaving a carbon crust. Once the reaction starts, it continues to give off energy. (Scientific Objective A)

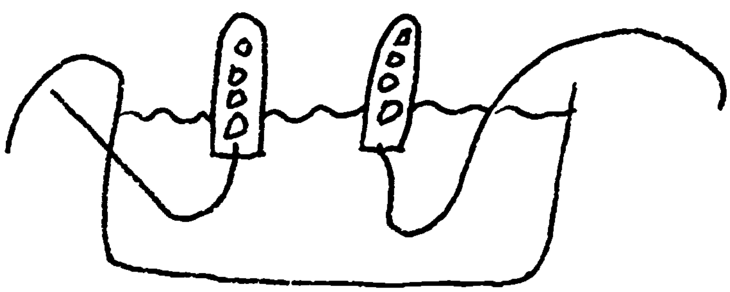
25. Use section on Utilization of Atomic Energy. Especially sections 1 and 2.

    Use electric magnets to suspend an object in mid-air to show the containment of fusion reaction.

    Demonstrate two compounds forming one compound and the giving off of energy. Demonstrate chemical combining by heating powdered sulfur in a test tube with steel wool. After the reaction is complete, note that the new substance is no longer magnetic (like steel) or soluble in trichlorothane (like sulfur). The new compound is different. When the reaction starts, the tube glows red, showing emission of energy. (Scientific Objective C)

26. Obtain a light meter that is used for cameras. Observe the needle moving as the meter is placed in a lighted oven. What causes the energy that made the needle move? How big would be a set of photoelectric cells to provide enough energy for a single-family household? (Scientific Objective D)

27. Do electrolysis of water by placing electrodes in separated test tubes.



    At the negative electrode, hydrogen gas will be generated at twice the rate of oxygen in the other tube.

    Use a burning splint to ignite the hydrogen gas in its tube. This activity demonstrates the ability of electricity to convert to hydrogen gas, which is another fuel. (Scientific Objective G-3)

ETHICAL OBJECTIVE ACTIVITIES

28. The student will pretend he is the program chairman of a local public-service club. Write a speech to explain a bond issue that calls for construction of a sewage treatment plant.

    Identify action groups in the community who might influence decisions concerning construction of such a plant.

    Attend a meeting of a municipal planning group.

    Collect information from such groups as the League of Women Voters and other organizations that might produce pamphlets and other material on such a subject.

    Interview candidates for local office regarding their position on improvements in the munic ' treatment of garbage and rubbish. (Ethical Objective A)

29. The student will give examples that show the difference between basic scientific research and applied technology.

    Give the types of technology you would like to pursue or have someone else pursue for the betterment of our living conditions.

    List various kinds of educational requirements needed in order to pursue a career in technology.

    List the educational institutions in the community which prepare students for careers in technology or science. (Ethical Objective C)

AESTHETIC OBJECTIVE ACTIVITIES

30. The student will design what he considers the most aesthetically acceptable form of energy for efficient housing. Justify the choice.

    Design the most aesthetically acceptable form of transportation, remembering that it must be powered by a source which is relatively unused today. (Aesthetic Objective B)

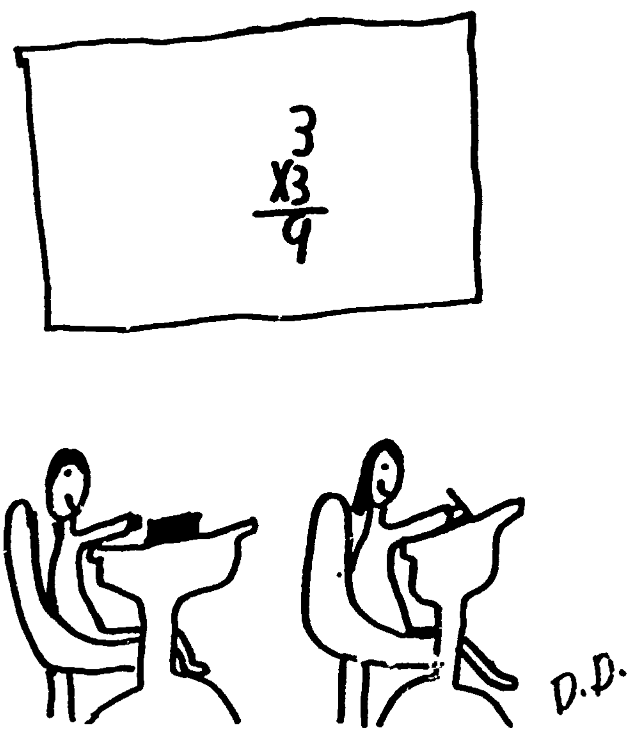
31. Obtain a copy of "Siting of Nuclear Power Plants" from the Atomic Energy Commission. List the major factors involved in the siting of a nuclear power plant and relate each factor to aesthetic considerations. (Aesthetic Objective D)

UTILITARIAN OBJECTIVE ACTIVITIES

32. The student will assume he is the mayor of his city. Describe the qualifications of the person he would hire to establish a public transportation system. Include educational background, occupational experience, political philosophy and other factors considered important. How would he be expected to approach the problem? To whom would he be answerable? (Utilitarian Objective B)

33. The student will investigate stock-market trends and activities the last two years for three firms that produce pollution-control or monitoring systems. Make a graph of your findings. (Utilitarian Objective C)

34. Coal, oil and natural gas are used as essential ingredients in the manufacture of many everyday items, including plastics, synthetic fibers for clothes, etc. Bearing in mind that these hydrocarbons are available only in finite amounts, discuss the energy mix (the relative percentages of different fuels). (Utilitarian Objective G)



35. SURVEY: "HOW IS YOUR COMMUNITY RESPONDING?"

YES	NO	UNDECIDED	
			a. Are wastes treated?
			b. Does your community have a waste treatment plant?
			c. Is your waste-treatment plant primary?
			d. Is your waste-treatment plant secondary?
			e. Is your waste-treatment plant tertiary?
			f. Do industries dump their wastes into the community treatment plant?
			g. Do industries bypass your community's waste-treatment plant and dump their wastes into local water sources?
			h. Do industries dump their untreated wastes into local water sources?
			i. Do homeowners dump their untreated wastes into local water sources?
			j. Do businesses dump their untreated wastes into local wate sources?
			k. Is some waste bypassed into local water sources during normal dry weather? a. What % ________ b. How often ________
			l. In wet weather, when lines and plants may be taxed by storm flow, is some sewage bypassed into local water sources? a. What % ________ b. How often ________
			m. Does your waste-treatment plant have enough employees to operate it efficiently on a 365-day basis?
			n. Does your waste treatment plant have enough employees to operate it efficiently on a 24-hour basis?
			o. Is a training program provided for waste-treatment operators in your community?

YES	NO	UNDECIDED	
			p. Does your waste treatment plant provide on-the-job training?
			q. Is your training program paid for by the community?
			r. Is your treatment plant up to date?
			s. Does your community require connection to a public waste treatment plant? a. How many sewer pipes are not connected with a waste treatment plant?__________
			t. Does your community prohibit its sewer system to be connected with storm water drains?
			u. Does your community have a sewage treatment problem?

What do You do Now?

SECONDARY AND SENIOR HIGH

SCIENTIFIC OBJECTIVE ACTIVITIES

36. Discuss the use of sewage and garbage in a municipal composting operation. Identify the roles of sewage and garbage and the complementary effects of each. (Scientific Objective A-1)

37. The student will prepare a chart listing the countries of the world now engaged in fusion research. Include appropriate identifying factors, e.g., laser, magnetic fields, etc. Indicate direction of and anticipated practical applicability of those systems. Unsolved problems of these systems should be identified. (Scientific Objective A-4)

38. A city or municipality decides to help conserve heat and plans to use some of the heat energy which is wasted from the local coal-fired electric production plant. List all the advantages and disadvantages of the plan.

    Determine what factors might inhibit implementation of the plan. (Scientific Objective B)

39. The student will assume an orbiting space platform is equipped with cells to convert solar energy to electric energy. List three or more ways to get that energy to earth. (Scientific Objective F)

40. Use lead foil and electrolyte of Na_2SO_4.

Let lead electrodes extend from fr [illegible] is coiled with cardboard or paper towels to prevent a short c[illegible]. Charge the batteries with an electric battery charger. Use a charged lead storage battery to run a light bulb, electric motor, etc. (Scientific Objective G-2)

41. Measure SO_2 in auto exhaust with the following experiment.

QUALITATIVE ANALYSIS OF SULFUR DIOXIDE IN THE AIR.

SO_2 is produced primarily from the burning of sulfur-containing fuel. If excess oxygen is present during burning, some SO_3 is also produced. Both SO_2 and SO_3 combine readily with water to form sulfurous and sulfuric acids.

$$SO_2(g) + H_2O \rightleftharpoons H_2SO_3 \qquad \text{Eq. 1}$$
$$SO_3(g) + H_2O \rightleftharpoons H_2SO_4 \qquad \text{Eq. 2}$$

The following is a description of a modified West Gaeke method which is extremely sensitive to SO concentration. This method uses common industrial dye called parasaniline hydrochloride.

Step I: An air sample of 10 to 40 liters is bubbled through an absorbing solution containing tetrachloremercurate (II) ion, which fixes the SO_2 in the air by the following reactions:

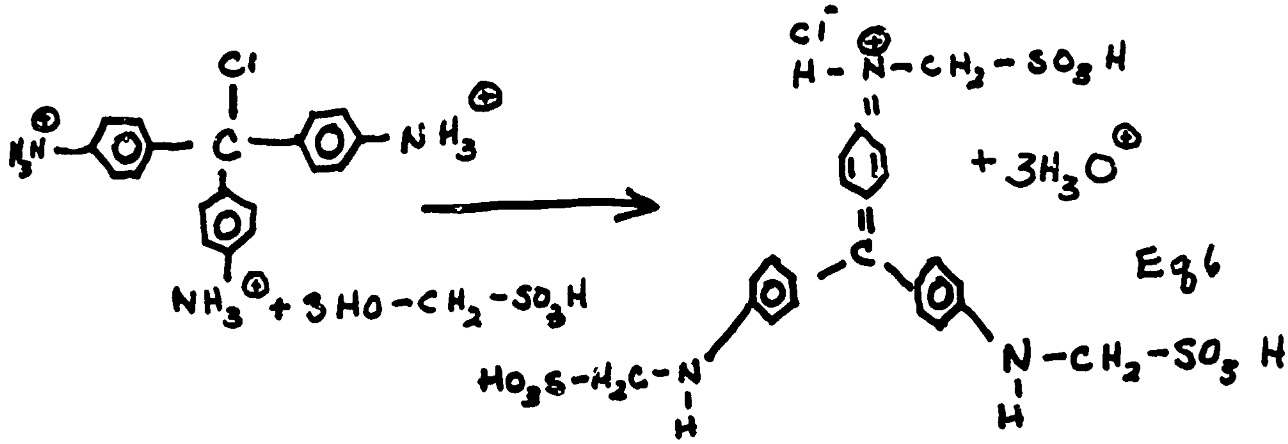
$$SO_2(g) + H_2O \rightleftharpoons H_2SO_3 \qquad \text{Eq. 3}$$
$$HgCl_4^{=} + H_2SO_3 \rightarrow [HgCl_2SO_3]^{=} + 2H^{+} + 2Cl^{-} \qquad \text{Eq. 4}$$

A stable complex, dichlore sulfite mercurate (II) ion, is formed. By forming a solution of this stable SO_2 derivative in the field, the fixed SO_2 can be taken back to the laboratory for further analysis with no loss of SO_2.

Step II: In the laboratory, formaldehyde is added, causing the following reaction:

$$2H^{+} + [HgCl_2SO_3]^{=} + HCHO \rightarrow Hg^{++} + 2Cl^{-} + HO\text{-}CH_2\text{-}SO_3H \qquad \text{Eq. 5}$$

Step III: Addition of green-yellow, acid bleached parasaniline hydrochloride produces on reaction with the product of step 2 the intensely reddish-purple parasaniline methyl sulfonic acid. The reaction shown in equation 6 is slow and the complex formed is not very stable.



During the development of the colored product the solution should be protected from strong light. The above illustrates the Schiff reaction between parasaniline, formaldehyde and sulfur.

REAGENTS

0.1 mg Na_2HgCL_2 Solution: Mix 27.2 gm $HgCl_2$ (0.1 mele) and 11.7 gm NaCL (0.2 mele) per 1000 ml

If NO_2 is present it :ll hinder the reaction: If you suspect NO_2 add 0.6 gm amidesulfonic acid to 1 liter of Na_2HgCl_2 solution.

Formaldehyde Solution: Use a 0.2% solution made as follows: 5 ml 40% formaldehyde made up to 1000 ml.

Parasaniline Solution: Make up a 1.0% solution by weight and allow to stand for 24 hours to compensate for hydrolysis.

Combine 4.0 ml of the 1.0% parasaniline solution with 6 ml concentrated HCl and shake until brown color disappears, make up to 100 ml.

PROCEDURE:

1. Pass the gas through 100 ml of Na_2HgCl_2 solution over a period of 10 to 30 minutes.
2. Add 10 ml of formaldehyde solution.
3. Add 10 ml of parason ________ hydrochloride solution.

RECORD OBSERVATIONS

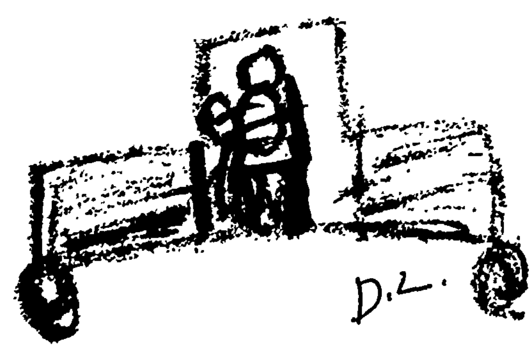
TEACHER REFERENCE: See

a. W. Laithe, The Analysis of Air Pollutants, Humphrey Science Publishers, Ann Arbor, Mich., 1970, p. 154-177.

This offers a clear explanation of the various methods that have been used to measure SO_2 in the air. Other pollutants are also discussed.

b. R.V. Naumann, P.W. West, F. Trou, and G.C. Gaeke, Anal. Chem. 32, 1307 (1960)

This article explains in some detail the chemistry of the West-Gaeke method in a clear and understandable manner.



ETHICAL OBJECTIVE ACTIVITIES

42. Go to the County Planning Commission. Examine land use plans. Examine topographic maps with drainage patterns and determine the best locations for the county dumps and sewage treatment plants. Compare with their actual present locations. (Ethical Objective A)

43. The student will list those organizations in the state involved in scientific research. Find one piece of research one of these organizations has completed. (Ethical Objective C)

AESTHETIC OBJECTIVE ACTIVITIES

44. (Teacher's Instruction: Use a sound-level meter from page 11 of Sound Pollution, by Peter A. Brysse.)

    Survey the noise levels of various community situations such as department stores, streets, freeways, office areas, classrooms, etc. Interview the people who live or work in those environments to determine if they think that environment is satisfactory as far as noise is concerned. Determine what noise irritants they find most objectionable. Attempt to determine what effect noise has on them. For instance, does it make them irritable? Is it a detriment to concentration? Does it result in a reduction in job proficiency? Does it result in any physical disability? What else? (Aesthetic Objective C)

45. After determining the site requirements of a nuclear-fueled power plant and after considering human aesthetic needs, design a setting for that plant and build a model of it. Then write a set of guidelines for human aesthetic site requirements. (Aesthetic Objective D)

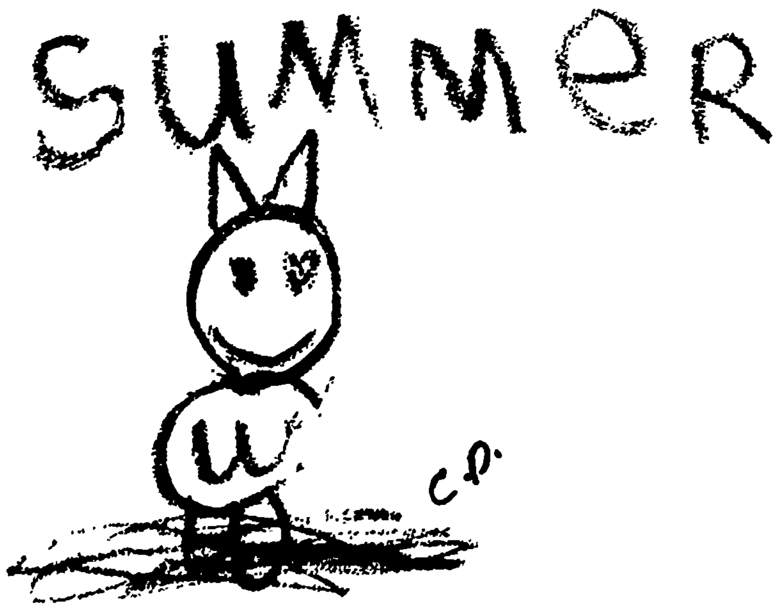
UTILITARIAN OBJECTIVE ACTIVITIES

46. How could industrial plants be designed to increase profits and simultaneously reduce or eliminate air and water pollution i.e., process and sell the effluents. (Utilitarian Objective C)

47. The student will write a proposal for a research project that will help to alleviate a forthcoming local energy crisis. The proposal should include:

a. a problem statement
b. clearly quantified delineation of the need
c. proposed hypotheses or objectives
d. budget
e. procedures
f. personnel needs
g. an evaluation design

Find what sources might be approached for funding such a project. (Utilitarian Objective D)



G L O S S A R Y

APPLIANCE SATURATION - Ratio of the number of homes using a specific appliance to the total number of homes.

AVERAGE MEGAWATT - A unit of average energy output over a specified time period (total energy in megawatt-hours divided by the number of hours in the time period).

BASE LOAD - See Load, Base.

BLOWDOWN - Water drawn from boiler systems and cold water basins of cooling towers to prevent buildup of solids concentrations. Usually contains chemicals used for pH adjustment and slime control.

BRITISH THERMAL UNIT (Btu) - The standard unit for measurement of the amount of heat energy, such as the heat content of fuel. Equal to the amount of heat energy necessary to raise the temperature of one pound of water one degree Fahrenheit.

CAPABILITY - The maximum load which a generator, turbine, power plant, transmission circuit, or power system can supply under specified conditions for a given time interval without exceeding approved limits of temperature and stress.

Maximum Plant Capability (Hydro) The maximum load which a hydroelectric plant can supply under optimum head and flow conditions without exceeding approved limits of temperature and stress. This may be less than the overload rating of the generators due to encroachment of tailwater on head at high discharges.

Peaking Capability - The maximum peak load that can be supplied by a generating unit, station, or system in a stated time period. For a hydro project the peaking capability would be equal to the maximum plant capability only under favorable pool and flow conditions, often the peaking capability may be less due to reservoir drawdown or tailwater encroachment.

Ultimate Plant Capability (Hydro) - The maximum plant capability of a hydroelectric plant when all contemplated generating units have been installed.

CAPACITY - The load for which a generator, transmission circuit, power plant, or system is rated. Capacity is also used synonymously with capability.

Dependable Capacity - The load-carrying ability of a station or system under adverse conditions for the time interval and period specified when related to the characteristics

CAPACITY FACTOR - The ratio of the average load on the generating plant for the period of time considered to the capacity rating of the plant. Unless otherwise identified, capacity factor is computed on an annual basis. In this Appendix, the capacity factor of a hydro plant is based on maximum plant capability and assumed load equal to the average annual energy.

CIRCULATING WATER - See Condenser cooling water. In a closed-cycle cooling system, this refers to the heated water from the condenser which is cooled, usually by evaporative means, and recycled through the condenser.

CONDENSER COOLING WATER - Water required to condense the steam after its discharge from a steam turbine.

CONVENTIONAL HYDROELECTRIC PLANT - A hydroelectric power plant which utilizes streamflow only once as it passes downstream, as opposed to a pumped-storage plant which recirculates all or a portion of the streamflow in the production of power.

COOLING WATER CONSUMPTION - The cooling water withdrawn from the source supplying a generating plant which is lost to the atmosphere. Caused primarily by evaporative cooling of the heated water coming from the condenser. The amount of consumption (loss) is dependent on the type of cooling employed--direct (once-through) cooling pond, or cooling tower. When not returned to the source of supply, blowdown is also included as a consumptive loss.

COOLING WATER LOAD - Waste heat energy dissipated by the cooling water.

COOLING WATER REQUIREMENT - The amount of water needed to pass through the condensing unit in order to condense the steam to water. This amount is dependent on the type of cooling employed and water temperature.

COORDINATED COLUMBIA RIVER SYSTEM - Contractually, the system of hydroelectric projects located on the Columbia River and major tributaries which are operated together on a coordinated basis under the terms of the Pacific Northwest Coordination Agreement.

DEMAND - The rate at which electric energy is delivered to or by a system at a given instant or averaged over any designated period of time, expressed in kilowatts or other suitable units.

DRAWDOWN - The distance that the water surface of a reservoir is lowered from a given elevation as the result of the withdrawal of water. Drawdown may refer to the maximum drawdown for power operation, from normal full pool to minimum power pool. Sometimes drawdown is also expressed in terms of acre-feet of storage withdrawn.

ELECTRO-PROCESS INDUSTRY - An industry which requires very large amounts of electricity in manufacturing for heat or chemical processes (as distinguished from wheel-turning or mechanical applications). Examples are electric furnace steel, aluminum, and chlorine.

ENERGY - That which does or is capable of doing work. It is measured in terms of the work it is capable of doing; electric energy is commonly measured in kilowatt-hours or average megawatts.

Average Annual Energy - Average annual energy generated by a hydroelectric project or system over a specified period. In the Pacific Northwest the average output of most projects is based on the historical flows experienced during the period 1928-58, as modified by appropriate irrigation depletions.

Firm Energy - Electric energy which is considered to have assured availability to the customer to meet all or any agreed upon portion of his load requirements. Firm energy is based on certain specified probability considerations, which, in the Pacific Northwest, are related to the 1928-58 sequence of historical streamflows adopted for making system power regulations. System firm energy capability includes hydro system prime energy, thermal plant energy capabilities, and firm imports.

Prime Energy - Hydroelectric energy which is assumed to be available 100 percent of the time: specifically, the average energy generated during the critical period.

Secondary Energy - All hydroelectric energy other than prime energy: specifically, the difference between average annual energy and prime energy.

Usable Energy - All hydroelectric energy which can be used in meeting system firm and secondary loads. In the early years of this study, it is possible that there may not be a market for all of the secondary energy which could be generated in years of abundant water supply and some of the water may have to be diverted over project spillways and the energy wasted.

ENERGY CONTENT CURVE - A seasonal guide to the use of reservoir storage for at-site and downstream power generation. It is based on the following constraints: (1) During drawdown sufficient storage shall remain in the reservoir to insure meeting its share of the system firm energy requirements in the event of critical period water conditions, (2) Draft of storage for secondary energy production is permitted only to the extent that it will not jeopardize reservoir refill by the end of the coming July. Drafting below the assured refill level is permitted only if required to meet firm energy loads or if such draft is secured by a commitment to return energy equivalent to the drafted water if refill is not otherwise accomplished.

FOSSIL FUELS - Coal, oil, natural gas, and other fuels originating from fossilized geologic deposits and depending on oxidation for release of energy.

GENERATION - The act or process of producing electric energy from other forms of energy; also the amount of electric energy so produced.

GIGAWATT - One million kilowatts.

HEAD

Gross Head - The difference of elevations between water surfaces of the forebay and tailrace under specified conditions. In this Appendix, gross head generally refers to the difference between normal full pool and average tailwater.

Net Head (Effective Head) - The gross head less all hydraulic losses except those chargeable to the turbine.

HEAT RATE - A measure of generating station thermal efficiency, generally expressed as Btu per (net) kilowatt-hour. It is computed by dividing the total Btu content of the fuel burned (or of heat released from a nuclear reactor) by the resulting net kilowatt-hours generated.

HYDRAULIC CAPACITY - See Capacity, Hydraulic.

INDEPENDENT RESOURCES (HYDROELECTRIC) - The hydroelectric projects of the region which are not included in the Coordinated Columbia River System.

IMPORTS - Power imported from outside the Columbia-North Pacific Region system.

INTERTIE - See Transmission Interconnection.

KILOWATT (kw) - The electrical unit of power which equals 1,000 watts or 1.341 horsepower.

KILOWATT-HOUR (kwh) - The basic unit of electrical energy. It equals one kilowatt of power applied for one hour.

LOAD - The amount of power delivered to a given point.

Base Load - The minimum load in a stated period of time.

Firm Load - That part of the system load which must be met with firm power.

Peak Load - Literally, the maximum load in a stated period of time. Sometimes the term is used in a general sense to describe that portion of the load above the base load.

LOAD DIVERSITY - Literally refers to the difference between (1) the sum of the separate peak loads of two or more load areas and (2) the actual coincident peak load of the combined areas. As used in this Appendix, the term applies to the load diversity between two load areas which occurs when their annual peak loads occur in different seasons of the year.

LOAD FACTOR - The ratio of the average load over a designated period to the peak load occurring in that period. In this Appendix the term applies to annual load factor unless otherwise specified.

LOAD SHAPE (LOAD PATTERN) - The characteristic variation in the magnitude of the power load with respect to time. This can be for a daily, weekly, or annual period.

LOSSES (ELECTRIC SYSTEM) - Total electric energy loss in the electric system. It consists of transmission, transformation, and distribution losses and unaccounted-for energy losses between sources of supply and points of delivery.

MEGAWATT (mw) - One thousand kilowatts

MEGAWATT-HOUR (mwh) - One thousand kilowatt-hours.

NORMAL FULL POOL - The maximum forebay water surface elevation within the reservoir's normal operating range.

PEAK LOAD - See Load, Peak.

PEAKING - Power plant operation to meet the variable portion of the daily load. See Load, Peak.

PEAKING PLANT - A power plant which is normally operated to provide all or most of its generation during maximum load periods.

PENSTOCK - A conduit to carry water to the turbines of a hydroelectric plant (usually refers only to conduits which are under pressure).

PLANT FACTOR - Same as Capacity Factor.

PONDAGE - Reservoir power storage capacity of limited magnitude that provides only daily or weekly regulation of streamflow.

POWER - The time rate of transferring energy. Note--The term is frequently used in a broad sense, as a commodity of capacity and energy, having only general association with classic or scientific meaning.

POWER SUPPLY AREA - Geographic grouping of electric power supplies as established by the Federal Power Commission in accordance with utility service areas.

PUMPED STORAGE PLANT - A hydroelectric power plant which generates electric energy for peak load use by utilizing water pumped into a storage reservoir during off-peak periods.

REREGULATING RESERVOIR - A reservoir located downstream from a hydroelectric peaking plant having sufficient pondage to store the widely fluctuating discharges from the peaking plant and release them in a relatively uniform manner downstream.

RESERVES

Reserve Generating Capacity - See Capacity, Reserve.

Spinning Reserve - Generating capacity connected to the bus and ready to take load. It also includes capacity available in generating units which are operating at less than their capability.

System Reserve Capacity - The difference between the available dependable capacity of the system, including net firm power purchases, and the actual or anticipated peak load for a specified period.

RULE CURVE - A seasonal guide to the use of reservoir storage.

RUN-OF-CANAL PLANT - A hydroelectric plant similar to a run-of-river plant but located on an irrigation canal or waterway instead of a stream.

RUN-OF-RIVER PLANT - A hydroelectric plant which depends chiefly on the flow of a stream as it occurs for generation, as opposed to a storage project, which has sufficient storage capacity to carry water from one season to another. Some run-of-river projects have a limited storage capacity (pondage) which permits them to regulate streamflow on a daily or weekly basis.

STORAGE PROJECT - A project with a reservoir of sufficient size to carryover from the high-flow season to the low-flow season and thus to develop a firm flow substantially more than the minimum natural flow. A storage project may have its own power plant or may be used only for increasing generation at downstream plants.

TAILWATER - The water surface immediately downstream from a dam or hydroelectric powerplant.

THERMAL PLANT - A power generating plant which uses heat to produce energy. Such plants may burn fossil fuels or use nuclear energy to produce the necessary thermal energy.

TRANSMISSION GRID - An interconnected system of electric transmission lines and associated equipment for the movement or transfer of electric energy in bulk between points of supply and points of demand.

TRANSMISSION INTERCONNECTION (INTERTIE) - Transmission circuit used to tie or interconnect two load areas or two utility systems.

ULTIMATE DEVELOPMENT - The maximum contemplated generating installation at a power plant.

Extracted from "Electrical Power"
Appendix VX, Columbia-North Pacific Region
Comprehensive Framework Study, October 1971

Bonneville Power Administration

ENERGY & MAN'S ENVIRONMENT

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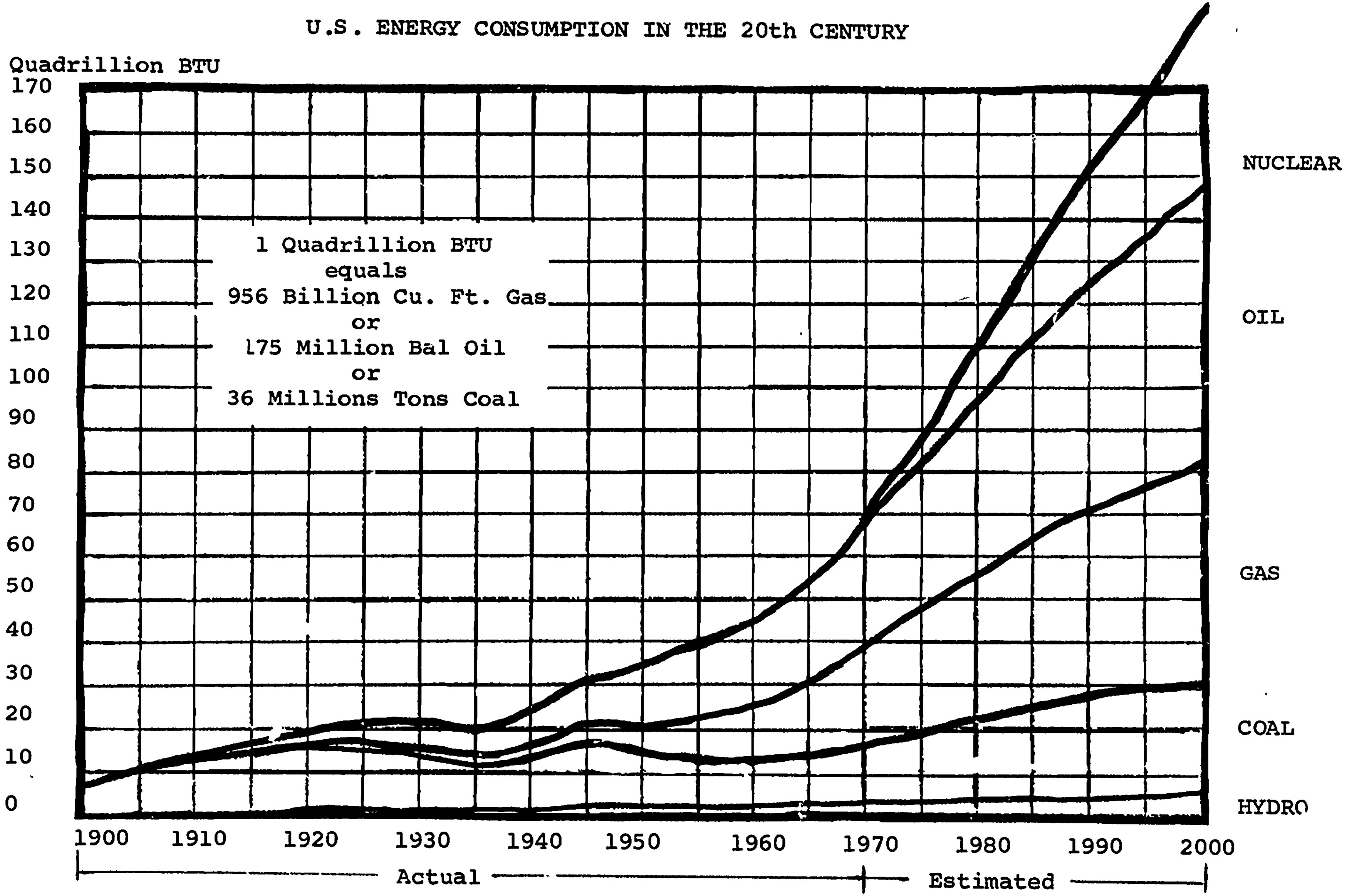
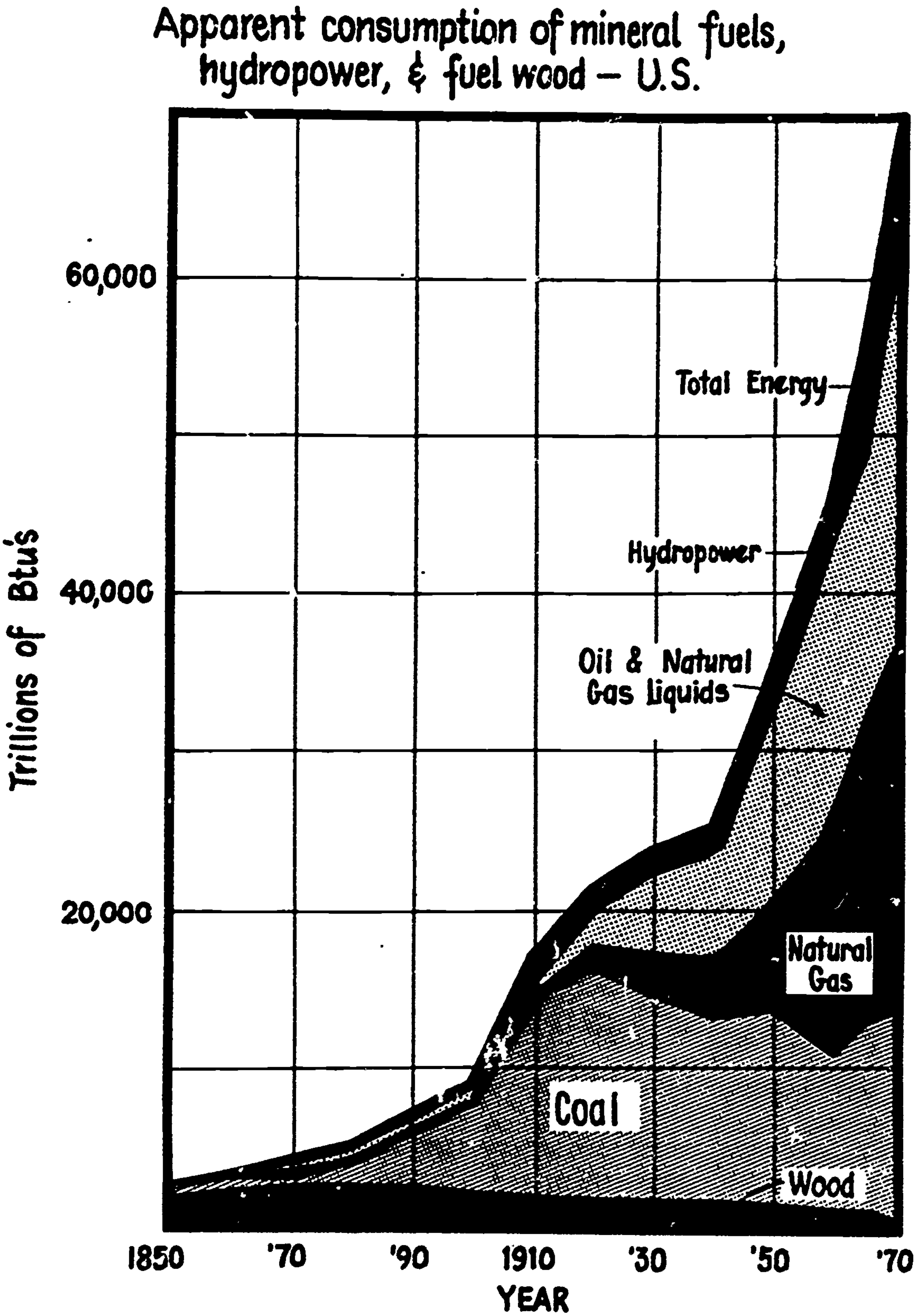
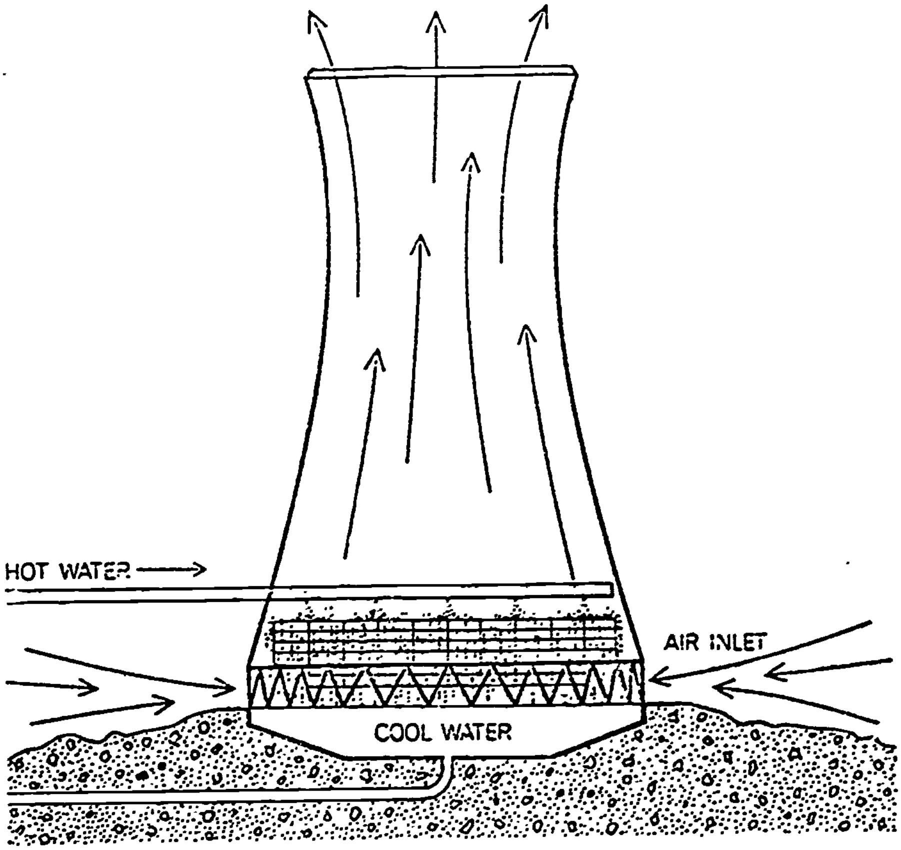
U.S. ENERGY CONSUMPTION IN THE 20th CENTURY



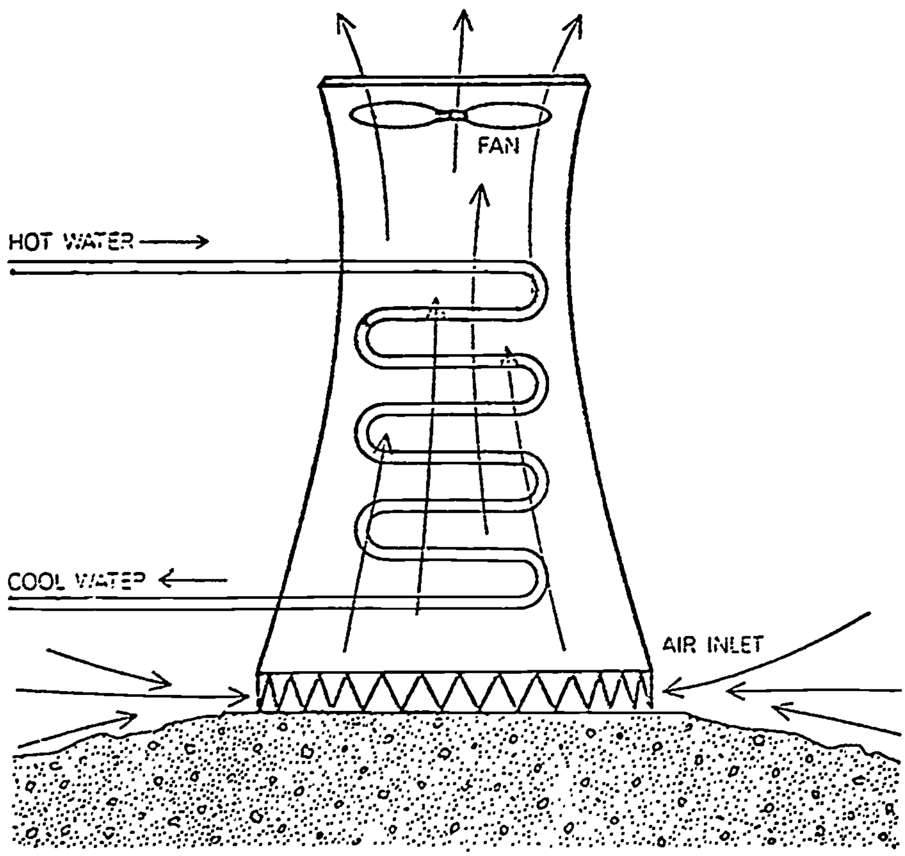
Department of Interior
March, 1971



The Electric Energy Picture in the Pacific Northwest. U.S. Department of Interior, Bonneville Power Administration, April 1, 1973.



COOLING TOWER is one device that can dissipate industrial heat without dumping it directly into rivers or lakes. This is a "wet", natural-draft, counterflow tower. Hot water from the plant is exposed to air moving up through the chimney-like tower. Heat is removed by evaporation. The cooled water is emptied into a waterway or recirculated through the plant. In cold areas water vapor discharged into the atmosphere can create a heavy fog.



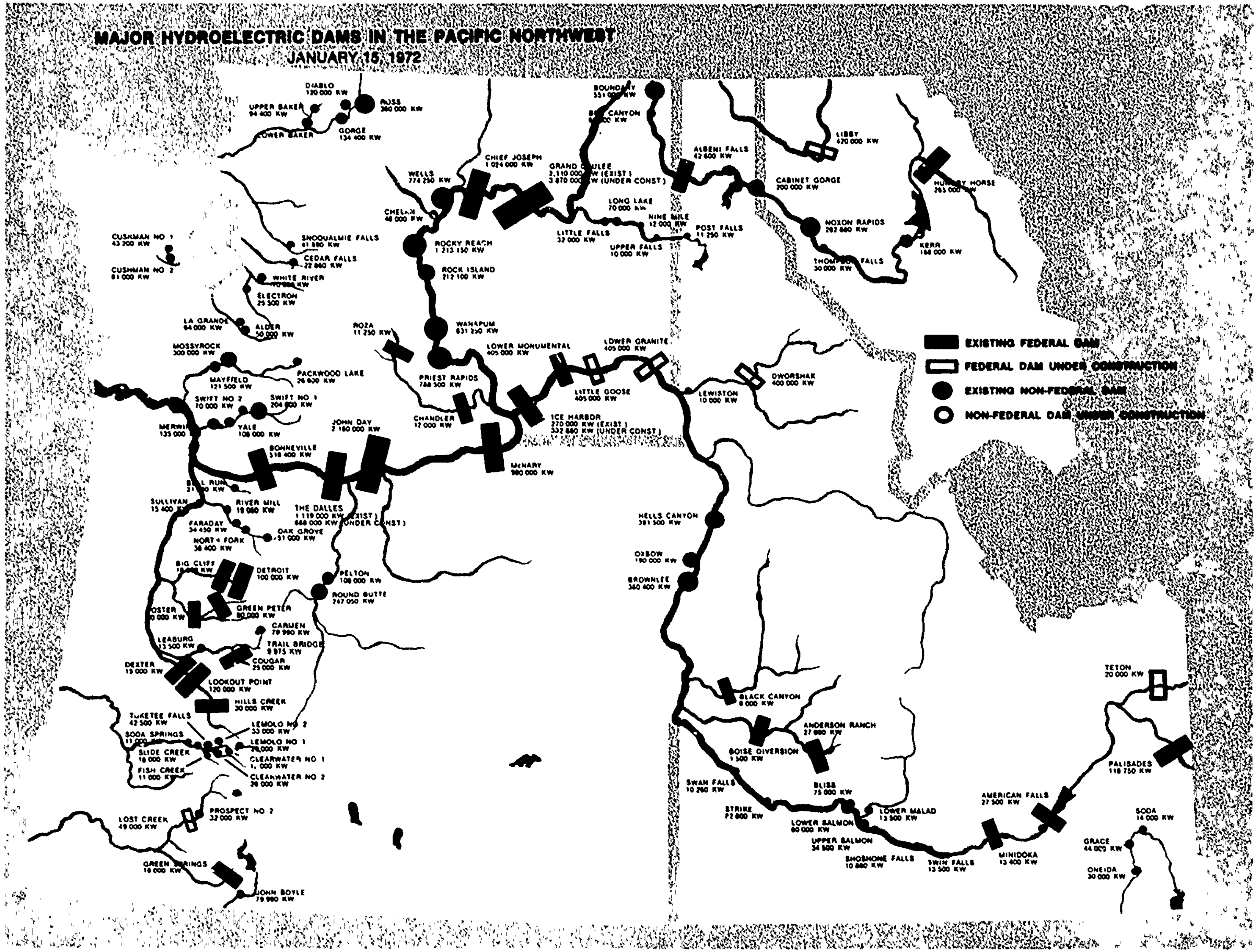
"DRY" COOLING TOWER avoids evaporation. The hot water is channeled through tubing that is exposed to an air flow, and gives up its heat to the air without evaporating. In this mechanical draft version air is moved through the tower by a fan. Dry towers are costly.

Estimated Saturation of Major Domestic Appliances

	Percent Saturation	Aver. KWH Use per Appliance	Aver. KWH Use per Dom. Cust.	Total Use per Appliance Millions of KWH	Percent of Total
YEAR: 1970					
No. of Domestic Customers - 1,985,569					
Major Appliances					
Air Conditioner-Room	15	935	140	278	1.0
Automatic Laundry 1/	40	1,360	544	1,080	3.9
Cooking Appliances	90	1,500	1,350	2,681	9.8
Dishwasher 1/	25	430	108	213	0.8
Freezer	20	1,500	300	596	2.2
Lighting	100	1,000	1,000	1,986	7.2
Refrigerator	95	1,400	1,330	2,641	9.6
Televison (Color)	40	525	210	417	1.5
Television (B&W)	80	360	288	572	2.1
Water Heater	80	4,000	3,200	6,354	23.1
Electric Space Heat	29	13,400	3,886	7,716	28.1
Auxiliary Electric Heat	25	1,080	270	536	2.0
Misc. Appliances			1,205	2,393	8.7
TOTAL			13,831	27,463	
YEAR: 1990					
No. of Domestic Customers - 3,161,000					
Major Appliances					
Air Conditioner-Room	75	935	701	2,216	2.8
Automatic Laundry 1/	90	1,360	1,224	3,869	5.0
Cooking Appliances	95	1,750	1,662	5,255	6.8
Dishwasher 1/	60	430	258	816	1.0
Freezer	50	1,760	880	2,782	3.6
Lighting	100	1,500	1,500	4,742	6.1
Refrigerator	99	1,850	1,832	5,789	7.4
Television (Color)	15	525	788	2,489	3.2
Television (B&W)	10	360	36	114	0.2
Water Heater	90	6,000	5,400	17,070	22.0
Electric Space Heat	50	13,500	6,750	21,338	27.4
Auxiliary Electric Heat	25	1,080	270	853	1.1
Misc. Appliances			3,299	10,428	13.4
TOTAL			24,600	77,761	

1/ Does not include electricity to heat water

SOURCE: Bonneville Power Administration
Branch of Power Requirements
April, 1972


MAJOR HYDROELECTRIC DAMS IN THE PACIFIC NORTHWEST
JANUARY 15, 1972
EXISTING FEDERAL DAM
FEDERAL DAM UNDER CONSTRUCTION
EXISTING NON-FEDERAL DAM
NON-FEDERAL DAM UNDER CONSTRUCTION
DIABLO 120 000 KW
ROSS 360 000 KW
UPPER BAKER 94 400 KW
GORGE 134 400 KW
LOWER BAKER
CUSHMAN NO 1 43 200 KW
CUSHMAN NO 2 81 000 KW
SNOQUALMIE FALLS 41 880 KW
CEDAR FALLS 22 860 KW
WHITE RIVER
ELECTRON 25 500 KW
LA GRANDE 64 000 KW
ALDER 50 000 KW
MOSSYROCK 300 000 KW
PACKWOOD LAKE 26 630 KW
MAYFIELD 121 500 KW
SWIFT NO 2 70 000 KW
SWIFT NO 1 204 000 KW
YALE 108 000 KW
MERWIN 135 000
BONNEVILLE 518 400 KW
JOHN DAY 2 160 000 KW
THE DALLES
RIVER MILL 19 080 KW
SULLIVAN 15 400
FARADAY 34 450 KW
OAK GROVE 51 000 KW
NORTH FORK 38 400 KW
DETROIT 100 000 KW
PELTON 108 000 KW
ROUND BUTTE 247 050 KW
GREEN PETER 80 000 KW
CARMEN 79 990 KW
LEABURG 13 500 KW
TRAIL BRIDGE 9 975 KW
COUGAR 25 000 KW
DEXTER 15 000 KW
LOOKOUT POINT 120 000 KW
HILLS CREEK 30 000 KW
TOKETEE FALLS 42 500 KW
LEMOLO NO 2 33 000 KW
SODA SPRINGS
LEMOLO NO 1
SLIDE CREEK 18 000 KW
CLEARWATER NO 1
FISH CREEK 11 000 KW
CLEARWATER NO 2 26 000 KW
PROSPECT NO 2 32 000 KW
LOST CREEK 49 000 KW
GREEN SPRINGS 16 000 KW
JOHN BOYLE 79 990 KW
CHIEF JOSEPH 1 024 000 KW
WELLS 774 250 KW
CHELAN 48 000 KW
ROCKY REACH 1 213 150 KW
ROCK ISLAND 212 100 KW
WANAPUM 831 250 KW
ROZA 11 250 KW
PRIEST RAPIDS 788 500 KW
CHANDLER 12 000 KW
LOWER MONUMENTAL 405 000 KW
LITTLE GOOSE 405 000 KW
LOWER GRANITE 405 000 KW
ICE HARBOR 270 000 KW (EXIST.) 332 880 KW (UNDER CONST.)
McNARY 980 000 KW
LITTLE FALLS 32 000 KW
LONG LAKE 70 000 KW
NINE MILE 12 000 KW
UPPER FALLS 10 000 KW
POST FALLS 11 250 KW
ALBENI FALLS 42 600 KW
LIBBY 420 000 KW
CABINET GORGE 200 000 KW
NOXON RAPIDS 282 880 KW
KERR 168 000 KW
LEWISTON 10 000 KW
DWORSHAK 400 000 KW
HELLS CANYON 391 500 KW
OXBOW 190 000 KW
BROWNLEE 360 400 KW
BLACK CANYON 8 000 KW
ANDERSON RANCH 27 000 KW
BOISE DIVERSION 1 500 KW
SWAN FALLS 10 260 KW
BLISS 75 000 KW
STRIKE 82 800 KW
LOWER MALAD 13 500 KW
LOWER SALMON 60 000 KW
UPPER SALMON 34 500 KW
SHOSHONE FALLS 10 880 KW
TWIN FALLS 13 500 KW
MINIDOKA 13 400 KW
AMERICAN FALLS 27 500 KW
PALISADES 118 750 KW
TETON 20 000 KW
SODA 14 000 KW
GRACE 44 000 KW
ONEIDA 30 000 KW

ENERGY & MAN'S ENVIRONMENT Activity Guide Postpaid "Feedback" Report

The ENERGY & MAN'S ENVIRONMENT Program actively seeks your ideas, comments and general suggestions about this Activity Guide. If you feel there are ways this Activity Guide could be improved, or if more and different learning objectives and activities could be added, let us hear from you. Tear out this perforated postpaid evaluation page from the Activity Guide and mail it or just write us a letter.

There is yet another request we make. If you feel that there are subject areas which need covering and should be included in a future Activity Guide, please let us know that too. Finally, give us an idea of what you are interested in and what you have done with this Activity Guide. Help us to keep in touch with you.

In anticipation of your response and contribution, thank you.
ENERGY & MAN'S ENVIRONMENT, 2121 Fifth Avenue, Seattle, Washington 98121

- -

Name (please print) ____________________
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- -

Chapter	Your Opinion						
	Very Useful			(check one)			Not Useful
Introduction							
Chapter 1							
Objectives	___	___	___	___	___	___	___
Activities	___	___	___	___	___	___	___
Chapter 2							
Objectives	___	___	___	___	___	___	___
Activities	___	___	___	___	___	___	___
Chapter 3							
Objectives	___	___	___	___	___	___	___
Activities	___	___	___	___	___	___	___
Chapter 4							
Objectives	___	___	___	___	___	___	___
Activities	___	___	___	___	___	___	___
Chapter 5							
Objectives	___	___	___	___	___	___	___
Activities	___	___	___	___	___	___	___
Chapter 6							
Objectives	___	___	___	___	___	___	___
Activities	___	___	___	___	___	___	___

1. All things considered, which of the following best describes your overall feeling about the EME Activity Guide behavioral outcomes.

Good ______ ______ ______ Neutral ______ ______ ______ Poor

a. If favorable, what do you particularly like about this Activity Guide?

b. If unfavorabl', what do you particularly dislike about this Activity Guide?

2. Were you able to integrate any of this material into your regular courses?
Yes ______ No ______

3. Please describe how you used the EME Activity Guide.

4. How could this EME Activity Guide be improved?

5. Would you share with us learning objectives and activities which might be helpful to others using a revised EME Activity Guide.

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